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ABSTRACT

Described are the four information bulletins produced by the ERIC Clearinghouse for Science, Mathematics and Environmental Education for the calendar year of 1979. The Spring 1979 issue contains a summary of the review of the literature in science education published from 1955-1975 as part of a project funded by the National Science Foundation. The Summer 1979 issue contains a summary of the mathematics education portion of this same literature review as well as announcements of recent publications produced by ERIC/SMEAC. The Autumn 1979 issue focuses on energy issues and contains a report of the National Assessment study of energy knowledge and attitudes as well as a report of a survey of energy consumption in the nation's schools which was completed by the American Association of School Administrators. This issue also contains some announcements of recent ERIC/SMEAC publications in environmental education. The Winter 1979 issue consists of representative abstracts from "Resources in Education" related to topics of current interest: science and the handicapped, safety, careers for women in science, calculators, math anxiety, mathematics assessment, energy education, and environmental education. (PB)

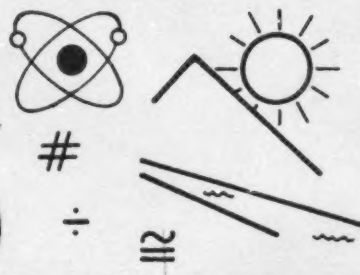
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Summary of NSF Literature Review in Science Education

As many of you know, the National Science Foundation sponsored three large-scale studies of science education, mathematics education and social science education. These studies took different forms for each project. One involved a nationwide survey of the public schools. This survey research was coordinated by Iris Weiss at the Research Triangle Institute in North Carolina. Robert Stake and Jack Easley and others conducted a series of case studies in which the investigators spent an extended period of time in the public schools and the communities they serve. The third took the form of a literature review covering the period 1955-1975. This literature review was done by personnel from the ERIC Clearinghouse for Science, Mathematics and Environmental Education and from the ERIC Clearinghouse for Social Studies/Social Science Education.

This issue of the ERIC-SMEAC newsletter will provide a summary of the major findings from the science education portion of the 1955-1975 literature review. The purposes of this review were (1) to review, analyze, and summarize the appropriate literature related to pre-college science instruction, to science teacher education, and to needs assessment efforts; and (2) to identify trends and patterns in the preparation of science teachers, teaching practices, curriculum materials, and needs assessment in science education for this twenty year period.

The twenty year time span was chosen because during this time, an unparalleled amount of activity in science education took place. Millions of dollars were spent in the development of science curriculum materials. The development of science course improvement projects involved, for probably the first time, scientists, educators and learning theorists. In addition extensive programs to upgrade and update the science content background of teachers were available as were programs designed to train science teachers in the use of the new curricula. This marked the first major investment of federal

monies directly in curricular and instructional concerns.

In order to identify the literature to be surveyed for the project, a comprehensive search of the ERIC data base was made (*Resources in Education, Current Index to Journals in Education*). The *Education Index, Reader's Guide to Periodical Literature, and Dissertation Abstracts International* were also searched for relevant documents. Collections of federal agencies were also included in the literature search. Questionnaires were sent to all state departments of education requesting information and documents dealing with state guidelines and policies, enrollment and course offering information, summary statistics, annual reports, planning documents, etc. Visits were made to 14 states by members of the project staff.

Over 6,000 documents were identified. The decision to select and review representative documents was made. Documents included in the review were chosen because of one or more of the following characteristics: (1) generalizability of results based upon size of population, sampling techniques, and methods of analysis; (2) summarization of data or research reports; (3) importance or significance as indicated by publication in a refereed journal or as a committee report; (4) representativeness of a type or kind of document. The final selection contained approximately ten percent of the documents that might have been included in the review.

The final report was divided into five major sections; existing practices and procedures in schools, science teacher education, controlling and financing education, needs assessment efforts, and a summary and trends of needs and practices.

School Practices and Procedures

Practices and Procedures in Schools

Data for this section were obtained from a review of over 600 individual re-

search studies, state and federal documents, and journal articles. When student enrollment was considered, several trends and influences were identified. Enrollment in elementary schools increased from 1955-1969, with the peak for grades K-6 being in 1968. Since 1969 enrollments have decreased. Public secondary school enrollment has increased each year since 1955, until 1977. Between 1955 and 1976 public secondary school enrollment more than doubled. Causes for this appear to be both the increased birth rate and the increased holding power of the schools.

Based on current elementary school enrollments, current non-public school enrollment trends, and the expected holding power of the public schools, a decrease in enrollment is projected until at least 1985.

Both expansion and reduction of enrollment have resulted in changes in the public schools. Increased enrollments have meant increased school staff, increased expenditures for school buildings, and an increased variety of courses offered by the public schools. Declining enrollment results most obviously in decreased revenue. This causes budget reductions, staff cuts, and decreased needs for materials and equipment.

In terms of organizational pattern, most schools are grouped at grades K-6 or 1-6 or K-8 or 1-8 for elementary schools and grades 7, 8 and 9 or 7-8 for junior high schools, with high schools housing grades 10-12 or 9-12. Middle school patterns are emerging but there is as yet no one predominant pattern of middle school organization. The most common pattern for teaching science in the elementary grades is the self-contained classroom. The use of departmentalization and special teachers in grades 6-8 is receiving increased emphasis. Secondary school science is taught, in most instances, by persons whose primary area of certification is science. While there are some analyses which indicated team teaching for science classes, the individual teacher teaching a class is by far the most common pattern.

In the mid-1970's the usual school day consisted of six or seven 45-60 minute periods. Many teachers consider that such a schedule reduces the opportunity for many science laboratory periods and outdoor activities. However, probably fewer than ten percent of the schools have any modular schedule or type of plan that differs from this. Substantial modification of daily school schedules does not appear to have gained much support in the past two decades, although much has been written about the usefulness of flexible schedules that allow for time variations.

Curricular Patterns: Elementary School Science

During the late 1950's and early 1960's considerable interest was focused on what should be taught and how it should be taught. Studies indicate that about 80 percent of the primary teachers and 90 percent of the intermediate grade teachers based their instruction in science on a single textbook. A curriculum for most schools was a textbook series for grades 1-6 (or 8) or two series, one used for the lower grades and the second, for the upper grades.

Science educators felt that if science in the elementary schools was to be improved, there should be more care and emphasis on the selection of content, reduction in the amount of content to allow for more depth, better organization of the way content was taught, more emphasis on the processes of science, more "hands-on" science activities rather than reading about science, and the use of a greater variety of media and materials for teaching science. Extensive National Science Foundation support was provided for the development of a number of alternatives to textbook programs for elementary school science in the 1960's.

Such programs as the Elementary Science Study (ESS), Science-A Process Approach (SAPA), Science Curriculum Improvement Study (SCIS), and others have had a marked effect on both classroom instruction and curriculum guides and on other instructional materials prepared by publishers. Data from surveys indicate that about 30 percent of the elementary schools surveyed have used or are using the NSF-sponsored materials. Use varies from state to state and within a state, however. Schools indicating the use of one of the elementary school curriculum programs (NSF-sponsored) frequently report the use of two or more programs.

Many of the elementary school science curricula show the influence of learning theory on science teaching, through the incorporation of the ideas of Gagne, Bruner or Piaget. Recent materials

show the impact of concerns about the environment and natural resources and the conservation of energy. During the past five years there has been growing concern on the part of educators and citizens that knowledge objectives of the elementary school programs were de-emphasized too much. Some of the recently-produced materials illustrate this concern, as do textbook adoption patterns — with a reduction in emphasis on laboratory work in science in many schools.

Few data are available relative to materials use and to the quality of instruction. Most of the available research studies focus on reports about a few teachers or a group explicitly involved in an inservice curriculum development project or implementation activity. Most studies have not followed teachers over time to determine the retention of gains in content knowledge or teaching skill or in the improvement of instruction as illustrated by student achievement or attitudes toward science.

Research reviewed indicates that the teacher's philosophy regarding what science should be taught and how science should be taught has a strong influence on the way teachers teach. This frequently is *not* a variable included in the data collection.

Curricular Patterns: Secondary School Science

When both elementary and secondary school science programs are considered, there is a fact that needs to be kept in mind. As school districts were consolidated and as enrollments increased, a small number of school districts have come to enroll a substantial percentage of the public school students of the United States. Approximately 29 percent of the students in the U.S. are enrolled in the 184 largest school districts. The 730 largest school districts have about 45-58 percent of the students enrolled. Therefore, a *relatively small number of school districts determine the educational programs for a large number of pupils.*

Science programs in the secondary schools have also undergone considerable change from 1955-1975. Prior to Sputnik I U.S. citizens were concerned about educating and training specialists in science, mathematics and engineering, with this concern related primarily to national security and to the scientific and technological progress attributed to the Russians. The science curriculum was predominantly the textbook. Curricula were constructed by purchasing a series of science textbooks. Data obtained from states and from reviews of surveys indicate the Holt books were the science curriculum in a large number of schools for grades 7-12. Holt dominated

the market in biology, chemistry, and physics.

After Sputnik I there was extensive production of instructional materials in science. In addition to funds from the National Science Foundation, the Elementary and Secondary Education Act (ESEA) and the National Defense Education Act (NDEA) provided considerable financial support for curriculum development, the purchase of equipment and for teacher education. The materials produced showed a reduced emphasis on "practical science" and an increased emphasis on concepts and processes of science. Until the early 1970's these materials did not have much emphasis on the interaction of science and society.

The influence of National Science Foundation funding in curriculum development has also been apparent when other science instructional materials are considered. Textbooks and laboratory manuals not funded by NSF projects show NSF influence in topics considered, types of laboratory activities included, content deleted, as well as in the organization of materials.

Relatively few content areas in science appear to be banned or restricted on a widespread basis. Only human reproduction and evolution as science topics are restricted in any substantial number of schools. Restrictions on teaching about human reproduction appear to have been substantially reduced in the last decade although evolution continues to be a topic debated when science curricula are considered in some states or localities.

In the middle 1950's general science was the most common course in grades 7, 8 and 9. In the late 1950's and continuing into the 1970's general science course enrollments have declined, with the most common replacements for this course being courses in life science or physical science or earth science. Enrollment in earth science courses showed a sharp rise in the two decades covered by the literature review, with most of this increase being in courses in grades 7, 8 and 9.

The percentage of students taking science in grades 10, 11 and 12 increased since the mid-1950's through the early 1970's. However, for about 50 percent of high school students, biology is the last science course taken — usually in grade 10. An increase in biology enrollment occurred from 1955 through the early 1970's, due in part (probably) to the increased holding power of the schools. In the past three years enrollment in biology has decreased slightly. Some of this decrease may be due to the fact that other science courses are available. Courses in marine biology, oceanography, physiology, integrated science, and environmental science may

attract students who once considered biology as a desirable alternative to chemistry or physics for their high school science credit.

There was a small percentage of enrollment gain in chemistry classes in the 1960's and early 1970's. Since 1971 the percentage of students enrolled in chemistry has declined slightly. The percentage of students enrolled in physics and physical science courses increased slightly in the 1960's and early 1970's, also with decreases in enrollment since 1972. The decrease in enrollment was larger for physics than for physical science.

Percentage enrollments in advanced science courses (second year biology, chemistry, physics) have shown a slow but steady increase, with advanced biology the most predominant. These advanced science courses appear to be available primarily in larger high schools.

The number of science courses offered as alternatives to the usual sequence of biology, chemistry and physics or physical science has shown a substantial increase since the late 1950's. Many of these courses are offered as one-semester units. Substantial increases in enrollment in such courses have occurred in the past five years.

Objectives for teaching secondary school science seem to be in transition. Reports of students' lacking practical knowledge as shown by National Assessment evaluations have led to increased interest in this aspect of science. The inclusion of environmental concepts, societal concerns and world problems, skill in decision making, and studies of an interdisciplinary nature has resulted in some reformulation of the objectives for science teaching.

Science Instruction: Elementary School

While curriculum and instruction appear closely related, research on inservice teachers has shown that teachers use similar materials in different ways as well as use different materials in similar ways. With the exception of the Intermediate Science Curriculum Study (ISCS) program and a few other projects, little has been done to change the structure of the teacher-student relationship in science classes.

The minimum competency movement has had very little noticeable effect on elementary school science at this time. Surveys completed in the early 1970's provide data to indicate that there is less emphasis in science on laboratory activities and field trips and more emphasis on materials that can be used for reading. It is difficult to identify reasons for this pattern. However, a study by the Institute for Educational Development

published in 1969 reported that patterns of materials selection may be related to size of school district, its socioeconomic character, financial constraints, and attitudes of school system personnel involved in materials selection.

In the elementary schools (especially in the larger districts), class size has decreased between 1960 and 1975. More hands-on instruction takes place in the elementary schools in science since the NSF projects were developed than occurred prior to these programs but a substantial number of elementary teachers still do not emphasize laboratory activities. Equipment available for teaching science has increased, in large part due to NDEA funds, with the use of educational television and films being highest in the lower elementary grades.

Elementary teachers surveyed in the early 1970's still indicate as barriers to teaching science the same items as those identified in the survey which Paul Blackwood conducted in the mid-1960's: (1) lack of consultant services, (2) lack of supplies, (3) lack of room facilities, (4) insufficient funds, (5) lack of sufficient knowledge, (6) lack of inservice opportunities, (7) inability to improvise, and (8) unfamiliarity with methods for teaching science. Research indicates that when these barriers are removed or reduced, the pattern of teaching is different but that insufficient effort has been made to reduce these barriers.

Science Instruction: Secondary School

With the exception of the mid-1960's survey of practices in junior high schools, conducted by L.E. Rogers (1967), no large-scale surveys of secondary school science instruction for the late 1950's and 1960's were identified. In the early 1970's a series of survey studies was conducted by doctoral students at The Ohio State University. Replication of selected aspects of these studies has provided additional data about secondary school science instruction.

There has been an increase in the use of student-centered activities in science. However, the lecture-discussion method still dominates. About half the schools surveyed indicated students were grouped for science instruction, most frequently in grades 7, 8 and 9 since courses in grades 11 and 12 tend to be elective. Some authors consider that chemistry and physics courses are self-selective based on the way they are currently taught.

Schools have become better equipped for science instruction. Federal funds have been used by over 50 percent of the schools to augment equipment. Some work has been done on individualized and self-paced science courses but a

very small number of students is exposed to these approaches. NSF-funded science curriculum materials have presented problems for average and below-average students due to high reading levels and difficulty of some of the concepts presented. The use of educational television and of computers appears to be increasing. Since 1955, the number of alternative materials for teaching science has increased markedly, presenting local schools with problems when they need to select and sequence these materials for science.

One aspect of the Ohio State survey studies involved the identification of correlates of effective instruction and good science programs. Over 50 percent of the respondents from the national sample identified these variables as important: (1) science facilities, (2) administrative support, (3) staff cooperation, (4) small classes, (5) a reasonable number of separate subject preparations, and (6) good instructional materials. Also identified, but as less important, were (7) teaching load, (8) inservice education, and (9) salary.

State requirements indicate that science is required for only one or two years of a four year high school program. Fifty percent or more of the high school students complete their science graduation requirement via a course in biology, usually in the tenth grade. There is, then, virtually no impact on these students relative to science in their last two years of high school. For most, their last physical science course was completed in junior high school. The role of science in the secondary school curriculum remains unclear. What science high school students should learn also remains unclear.

Science Facilities and Equipment

There is widespread agreement in the literature about the importance of science laboratories and facilities in the science program. A survey of 850 schools in 7 states showed that about half of the schools lacked adequate laboratory space and about one-third lacked adequate storage space. Data from the OSU surveys produced similar findings. Approximately 94 percent of the respondents rated science facilities in one of the two highest categories of important factors for a quality science program.

Sufficient space for preparation, storage and student activities is related to specific science curricula in many schools. Attempting to teach science in a regular classroom, without modifying it in some appropriate way, is not likely to be effective. Rogers, in her survey of junior high school science, reported that more than 25 percent had no laboratory facilities. No specific studies at this level conducted in more recent years were

identified to know if these conditions have changed.

In the OSU survey secondary schools were reported as having an annual budget for science equipment and supplies in about 64 percent and 76 percent of the cases, respectively. Most budgets reported were from one to three dollars per pupil per year. Again, in the 1937 junior high school study, about 70 percent of the schools reported having budgets for equipment and supplies for science but 20 percent reported no such budget items.

NDEA funds have helped in the purchase of science equipment and supplies. Sixty-nine percent of the secondary schools reported using such monies for science equipment purchase and for supplies. In addition, 15 percent reported using NDEA funds for remodeling science facilities in secondary schools. About 66 percent of the elementary schools reporting indicated that NDEA funds had been used for science equipment and supplies, according to the OSU survey studies. Such data appear to support the assumption that any alteration in federal funding would have a clear influence on science programs.

Science Teacher Education

Literature reviewed for this section of the project report related to both preservice science teacher education and inservice education. Journal articles, research reports and reviews, state of the art papers, state certification standards and guidelines proposed by professional organizations and groups were reviewed.

Preservice Science Teacher Education: Guidelines vs. Certification

The guidelines most widely referred to in science teacher education are those developed by the National Association of State Directors of Teacher Education and the American Association for the Advancement of Science (NASDTEC-AAAS). These guidelines are concerned with both the preparation of elementary teachers to teach science and mathematics and of secondary school science and mathematics teachers.

In 1961 NASDTEC and AAAS proposed a set of guidelines which was rapidly accepted. These guidelines, eight of which were considered common to all science fields and to mathematics, emphasized a thorough, college-level study of the subject which the preservice student was preparing to teach, with a major in the subject area rather than in education. This major was to include work in areas related to the subject to be taught. Ap-

propriate methods courses were to be included in the preservice student's program. This program was also to take into account the recommendations for curriculum improvement made at that time by various national groups.

At that time (1961) the American public was concerned about upgrading the public schools. One approach to this was to upgrade the preparation of future teachers. In addition, the National Council for Accreditation of Teacher Education (NCATE) helped bring about change by asking institutions seeking accreditation for their teacher education programs to show how these guidelines were being used.

The climate in the schools changed during the decade of the 1960's. This change was sufficient to make a revision of the 1961 NASDTEC-AAAS guidelines seem appropriate. In 1971 a new set was produced. This set focused on 12 areas of concern: (1) humaneness, (2) societal issues, (3) nature of science and mathematics, (4) science competencies, (5) mathematics for science teachers, (6) basic mathematics competencies, (7) algorithms and computing, (8) modeling in science and mathematics, (9) communication of science and mathematics, (10) learning conditions, (11) materials and strategies for teaching, and (12) continuous learning.

The 1971 guidelines did not overlook subject matter requirements. However, they had a broader focus than those of 1961, relating teacher education to liberal education. They also emphasized the idea that future teachers needed not only to be competent in their content area but they also needed to be familiar with societal issues and to develop a humane atmosphere in which teaching and learning are to take place in the classroom.

Because the 1971 guidelines are concerned with more than content proficiency, their impact is less easy to assess. When state certification criteria are considered, very little influence is apparent. Certification standards still focus on number of hours of work completed in the area of certification.

Again, trends in certification standards are difficult to identify. Certification is still basically a function of each individual state and, within a state, certification is based primarily on the "approved program" approach. Under this approach, each institution preparing teachers works within the broad framework specified by the state department of education for certification and translates these criteria into specific courses or preparation programs for a particular college or university. This provides institutions with much flexibility. It also makes the institution, rather than the state, responsible for deciding if an individual should be recommended

for certification. While states such as Maryland, for example, provide information to the effect that state standards for certification should be regarded as minimal and local systems may establish higher standards for certification, there is no indication that this "permission to increase rigor" is ever commonly acted upon.

As the American population became more mobile, reciprocity has been a topic of increased concern for teachers. Some states, such as Arizona, do not extend reciprocity to teachers with out-of-state certification although they do permit teachers to teach, with temporary certification, while completing requirements for more permanent certification. Other states specify that reciprocity will be extended to graduates of teacher education programs approved by NCATE, which is a national voluntary accrediting agency.

Content requirements in science for certification of elementary school teachers appear to have changed little over the past two decades. While some states specifically indicate a certain number of credit hours/courses in science, others consider science only as a part of the general education component of a preservice student's undergraduate program.

When secondary science teacher preparation requirements were considered, the picture changed. After Sputnik, science content requirements for most state certification programs increased. This reversed a previous trend in which the number of credits for professional education courses frequently exceeded that of content hours in a subject to be taught. Certification patterns are still, however, based largely on courses completed rather than upon classroom performance, despite the increase in articles in professional journals about competency-based/performance-based teacher education-certification.

Preservice Science Teacher Education: Programs

Much of the program description material was located in professional journal articles although two ERIC publications, "In Search of Promising Practices in Science Teacher Education" (1973) and "Secondary School Science Teacher Education: Where Are We Going?" (1974), both produced as cooperative efforts with the Association for the Education of Teachers in Science (AETS), do provide some program descriptions. The programs described are representative of those in both elementary science teacher education and in secondary school science teacher education.

During the years of the literature review program modifications for elementary teachers have been made to include

a greater emphasis on process skill development, both for the preservice teachers and for their future pupils. Other changes reported in teacher education programs involve the inclusion of such topics as humanism, relating science to contemporary social issues and problems (both of which reflect the 1971 NASDTEC-AAAS guidelines for teacher preparation), providing more and more extended field based experiences prior to student teaching, and involvement with inner-city students and other minority groups.

Some science educators have reported their institutions to be involved in competency-based or performance-based teacher education. This has occurred either because personnel at an institution are anticipating a change toward this approach or have been mandated to make the change. Advocates of PBTE/CBTE state that programs will benefit because (1) preservice teachers will be placed in classrooms to demonstrate their skills rather than remaining on campus and/or (2) progress of the preservice student will be controlled by the student himself rather than by courses completed. However, teacher educators and inservice teachers are not always in complete agreement about the competencies needed nor about the time at which the competencies should be demonstrated. Some college faculty are concerned that the development of the CBTE/PBTE approach to teacher preparation will mean that non-education faculty members (and their disciplines) will have little influence on the teacher certification process. The concern has also been expressed that competency-based certification standards may be developed without the capacity to assess adequately or to remedy a deficiency once it is found.

Although some states have certification standards for junior high school or middle school teachers, the science education literature does not indicate that colleges and universities have programs specifically designed to prepare science teachers to work with junior high or middle school pupils. There appears to be a lack of support from professional science education organizations for the education of teachers for junior high school/middle school science. Perhaps state departments of education will have to support and encourage colleges to develop such programs by setting certification standards for junior high school/middle school science teacher certification.

Preservice Science Teacher Education: Research

Much of the research material consisted of doctoral dissertations, journal articles reporting doctoral dissertations,

and yearly reviews of research (identifying primarily doctoral dissertations). Very few studies were of the scope that allowed for adequate generalizability to large problems in science education. Many studies appeared to lack a sound conceptual basis relative to the hypotheses tested or the questions investigated. Many failed to deal with other categories of variables that might be related to the specific variables under study.

While the studies lacked rigor, some showed that novel training experiences did produce some changes in teacher perceptions of one kind or another. However, there was little or no indication if these changes were temporary or not. Nor was there any indication of whether actions in classrooms related to particular sets of attitudes or perceptions. Also, the components in the training programs that might have accounted for these changes were not identified.

Studies of teacher attitudes and values did not always include information about whether any correlations existed between the attitudes teachers held and the way they taught. Research related to teaching skill development, classroom interaction (primarily verbal), and the use of microteaching increased during the past seven to ten years. This increase may be due, in part, to the increased concern for competency-based teacher education.

More research has been published relative to secondary science teacher preparation than to the preparation of elementary teachers to teach science. The number of studies in the area of the education, characteristics, and behaviors of teachers has increased significantly from 1972 through 1974.

When research published during 1974 was considered, studies seemed to indicate that effective programs could be developed to teach science process skills to elementary teachers, that this training was likely to influence the way teachers conduct science lessons, that participation in designing and carrying out investigations of their own was likely to be the most important component of such programs, that knowledge of science content was *not* highly related to the development of process skills, and that teachers in activity-centered programs had more favorable attitudes relative to science than those in the more traditional science programs.

Despite the increase in the amount of research produced, more research needs to be done — particularly follow-up studies of graduates, to determine the effectiveness of science teacher education programs. Research also needs to be done if any theory of instruction relative to science teaching is to be developed, at either the elementary or

the secondary school level. However, investigators, both doctoral students and more established science educators, need to pay attention to criticisms of science education research identified by reviewers of research and to improve their efforts.

Inservice science teacher education

Professional organizations have not developed specific sets of guidelines for inservice education for science teachers. This may be due in part to the fact that inservice education appears to mean different things to different people, with little agreement concerning its purposes. The continuing education of experienced teachers may not be generalizable but may be specific to the local setting.

Inservice education may be inferred from certification standards based on the criteria which must be met if a teacher is to exchange an initial certification credential for a more permanent one, but this does not hold true for all states. Several broad goals of inservice education are identifiable: skill training, acquisition of information, attitude change, and general self-improvement.

Preservice programs, no matter how field-based or competency-oriented, cannot educate a prospective teacher so thoroughly that the need for additional skill development is eliminated. Much inservice education has been accomplished through programs funded by the National Science Foundation: academic year institutes, summer institutes, cooperative college-school science programs. In general, NSF institutes and programs have had a beneficial effect on the teacher participants.

Generally, inservice activities have been designed to help experienced teachers keep current in their content area or gain new skills. Inservice education activities have tended to ignore the problems of beginning teachers and have failed to help beginning teachers become master teachers. Instead, inservice activities have, in addition to improving content knowledge, concentrated on helping teachers deal with the proliferation of educational hardware, function adequately in relation to new educational tasks (such as mainstreaming) or become more aware of information related to learning and instructional theory. More work needs to be done to evaluate the effectiveness of inservice education activities, however. Programs and activities appear, in many instances, to be developed to meet a specific need at a particular time with little thought to sequence and continuity of inservice programs. The net effect is often of the patch-work or band-aid variety with little or no formative or summative evaluation of programs and activities being done.

When one attempts to gain a description of the present science teaching population and to relate this description to possible inservice activities, elementary and secondary levels need to be considered separately. Elementary school science teaching still appears to be handicapped by deficiencies both in course content and in teaching methodology, as well as by inadequate teaching conditions in the public schools. Secondary school science teachers appear better prepared (decrease in number of teachers without a college degree, large number of NSF institute participants), younger (25 percent of the science teachers sampled in the OSU study had been teaching four years or less), and relatively satisfied with the career they chose. When junior high school science teachers are considered as a separate subgroup of secondary school science teachers, these people (on the whole) lack depth in more than one area of science. Yet, many fill general science teaching assignments (which assume both breadth and depth). Junior high school science teachers are less satisfied with the science curricula available, considering them less relevant to their pupils than they could be. They also express dissatisfaction with teaching conditions in terms of classroom facilities, equipment and storage space.

Inservice Science Teacher Education: Research

Again, most of the research literature relative to inservice science teacher education is of the doctoral dissertation variety. The criticisms identified earlier in this report hold true for research on inservice education as well as for pre-service education. Reports of research about inservice programs were often lacking in sufficient detail to ensure replication, if this should be desired.

Despite all of the reports of NSF teacher education efforts, Welch in a 1976 article in *Science Education* stated that no careful study of the influence of the NSF curriculum projects on teacher education had been made. Nor has the influence of NSF material on teachers and teaching been investigated. There also appears to be a need for the systematic study of success in achieving the general goals of the improvement of education for careers in science and the development of scientific literacy, according to Welch.

Some research has been done relative to the influence of inservice programs involving use of science curriculum project material and teacher behavior. There have been inconsistent findings at the secondary school level. However, at the elementary school level, there generally was an increase in student activity accompanied by an increase in teacher

procedural statements. (These findings, and others, are contained in the 1973 AETS-ERIC *Review of Research on Teacher Behavior*.) Both the 1970 and 1973 NARST-ERIC *Reviews of Research* contain positive findings relative to educating teachers to use curriculum project materials.

Science Teaching Today

The need for inservice education continues. Teachers have expressed needs for help in motivating students, in individualizing materials for instruction, and in the use of problem solving and decision making strategies, to name a few expressed needs. Information processing skills are needed by teachers to cope with the ever-increasing amount of science knowledge as well as methods for helping their students process information. If teachers are better prepared in their content area and more skilled in teaching techniques and strategies, they should be able to better promote student learning.

Science teachers in the 1970's are faced by public demands for accountability, for a return to the basics (whatever "basics" is defined to mean), and for improvement of test results reported by the National Assessment of Educational Progress (NAEP). Through NAEP efforts, science knowledge was tested in 1969-70 and in 1972-73. When data from these two rounds of testing were compared, there appeared to be cause for concern. The NAEP scores showed that (1) approximately 65,000 fewer 9-year-olds nationally could answer typical science questions in 1973 than in 1970, (2) approximately 70,000 fewer 12-year-olds could respond satisfactorily to typical science questions in 1973 than in 1969, and (3) approximately 80,000 fewer 17-year-olds could answer science questions correctly in 1973 than in 1969.

What has caused this drop in student learning? Is it more apparent than real? Opinions appear mixed. A seminar sponsored by the Thomas Alva Edison Foundation and the Institute for Development of Educational Activities, Inc. (I/D/E/A) resulted in a publication which identified 20 possible causes for the drop in learning. Seminar participants felt the responsibility for this decline should not be assumed by teachers alone but that it should be shared by parents, courts, legislators, bureaucrats, and school administrators.

A more recent explanation for the apparent phenomenon of declining test scores was presented at the 1977 meeting of the National Science Teachers Association. In a paper presented there, Welch identified several possible explanations: (1) invalid tests, (2) failure of schools to do their job properly, (3) out-of-school influences, (4) less time spent

on science, and (5) reduction in intelligence related to genetic factors and increasing family size. However, Welch suggested, the drop in test scores may be due to an increase in the affective outcomes of schooling. Using data from 350 science classes to support his hypothesis, Welch reported that in 1972 and 1976 pupils were tested with the Welch Science Process Inventory and the Test of Achievement in Science, a test composed of NAEP items. Also, 8,000 pupils completed two affective measures: Science Attitude Inventory and Learning Environmental Inventory-Satisfaction. Statistically significant declines on the achievement test and the process inventory were found. However, significant gains on measures of class satisfaction and science attitude were also identified. Perhaps, while students may be learning less science, they are enjoying it more.

Controlling and Financing Education

Controlling Education

School policies are shaped by many forces. Between 1955 and 1976 the state governments have expanded their activities in the number of functions in which they are involved in school structural organization, finance, curriculum and instruction. The influence of the state governments on science education has increased since 1955, due to regulations both related to science and not related to science. Both types of regulations can provide positive or negative influences on science education. Policies regarding school size and school consolidation, the school curriculum, certification, selection and purchase of textbooks and other instructional materials, and minimum competencies and accountability are all directly related to science teaching. In addition, policies regarding equality of educational opportunity for minority groups and for the handicapped also influence how science is taught.

In recent years the number of legislation and regulation items that relate to schools has increased. While funds have been provided by states for some of these requirements, in other cases no monies have been allocated. Passage of legislation or regulations without funds is frequently an action influencing curriculum. State governments differ markedly in the types and extent of influence they exert on elementary and secondary education. Regional patterns of influence also exist. Data examined for the literature review suggest the role of the state in science education is more important than commonly thought and the

influence of the state appears to be growing.

Financing Education

When data related to school revenue sources were considered, three patterns were identified: (1) increasing support from the federal government beginning primarily in the late 1950's and extending through 1965-66; (2) the percentage of state support has not shown a similar increase since the late 1950's, although the last three years suggest some possible change; and (3) the percentage of local support has shown a general decline.

State data for 1973-74 show that states differ substantially both on their sources of funds per pupil and the revenue and expenditures per pupil. Differences also exist among the many communities within a state. These differences have marked effects on science programs.

Since the late 1950's it appears that categorical state funds have frequently followed the pattern of federal funds. The present stage of federal participation in education began after World War II. From 1945-1952 funding was primarily to aid veterans in obtaining an education. During the last twenty to twenty-five years, funding patterns have changed to support programs which influence elementary and secondary education. Such activities as the National Science Foundation's teacher institute programs and course content improvement projects are obvious. Also influential are the National Defense Education Act of 1958, the Vocational Education Act of 1963, the Economic Opportunity Act of 1964, and the Elementary and Secondary Education Act of 1965.

There was growing federal support in total dollars for science education from the late 1950's through 1968. Beginning in 1964-65, federal legislation stressed the disadvantaged, career and vocational education, equality of educational opportunity, bilingual education and other activities. In some instances federal programs required matching money from local schools. This sometimes resulted in reallocation of funds with less money being allotted to science education. Another result was the discontinuance of special programs when federal support was no longer available. Since 1968, the financial assistance priorities established by federal programs and followed by states and most local schools have placed less emphasis on support for science education. This change is also reflected in the fact that science is seldom included in the first evaluation efforts of those states involved in the minimum competency (for promotion, graduation) movement.

When school funding is considered, both block aid and categorical aid are

apparent. If the purpose of the funding is to allow the schools to use funds in ways determined by them, block aid allows these decisions to be made by the state or local unit. If the purpose of the funds is to accomplish a defined objective, the use of categorical aid is more likely to be successful. A review of recent funding legislation indicates a reduction of categorical federal aid for science education since the late 1960's. Based on past patterns of state and federal funding, it is not likely that many states will give science a high priority if federal legislation does not.

The pattern of support for public schools indicates a general decline in the percentage of local revenue support for local schools. The problems which result have been documented in many reports and publications: inequality of tax base, differences in percentages of homes with school-age children in various communities, differences in increases or decreases of student enrollment during a fiscal year, differences in educational needs and problems in different communities, among many problems. From analyses of school financing, schools that currently have a low tax base per pupil and that depend heavily on local revenue will be most subject to problems previously described.

With the increasing mobility of the American population, especially within the states, increased state support of schools for the educational program needs to be carefully examined. Frustration of local reform efforts is high. Major reform efforts may have to be accomplished at the state level.

Cost Effectiveness of Science Instruction

Very few studies related to the cost effectiveness of science programs were found in the literature. Analyses of local school budget summaries for 11 states showed the major costs to a school to be (1) teacher salaries, (2) building construction payments, (3) building operation and maintenance, (4) transportation, (5) administrative and staff salaries, and (6) instructional materials and supplies. Teacher salaries are usually the major cost variable and are affected by (1) pupil/teacher ratio, (2) teacher's step on the salary schedule, and (3) amount of teacher and staff time required for instruction and planning. Most of the studies analyzed involved only a few teachers and seldom included information regarding salaries.

Instructional material costs represent a very small percentage of most school budgets. The amount is surprising, considering the investment in the other five areas listed previously. To demonstrate any substantial cost effectiveness of one successful program over another would

require manipulation of staffing patterns and/or building use. Such research is needed. Current technology can provide instructional alternatives not available in the 1950's and 1960's.

Needs Assessment Efforts

When literature for this section of the report was considered, both general educational needs and needs specifically related to science education were considered. Documents that were national in scope as well as those of a more regional or state-wide focus were included in the review.

Needs: General Education

A major need, identified in nearly every pertinent document reviewed, was for improved financing of education. Basic skills, particularly including reading, mathematics, communication and language arts skills, and fundamental knowledge in such areas as science, social science, and other discipline areas, were among the top needs identified in a majority of the cases. Equal educational opportunity for females, blacks, Indians, persons of Hispanic origin, migrants, inner city students, rural students, and bilingual students was identified as a major need.

Within the last decade, concern has increased for accountability in education. This includes both accountability for learning (such as performance contracting, competency-based education, and minimum performance requirements for graduation) and program management (such as PPBS, management by objectives, management information systems, and school consolidation and reorganization). Concern for vocational or career skills and knowledge has become increasingly important.

Life-long learning is also of increasing importance at the state level. This implies educational concerns beyond the level currently seen as the limit for formal education.

Desegregation and related educational problems, including financing, is a concern in many school systems. Concern for exceptional children and for special education, especially reflecting the needs of the handicapped, continues. There appears to be some increase in concern for the gifted students.

A number of schools indicated concern for programs to decrease the number of students dropping out of school. Dealing with the student as an individual, in terms of developing a positive self-image and also in individualiz-

ing instruction, is of increasing importance. Increasing problems with discipline and student management are reflected in many publications. Discipline was listed as one of three major problems of education in the Third Annual Report of the National Council of Educational Research, in *Educational Research: Limits and Opportunities*, a 1977 publication. This concern has been expressed in the literature prior to 1977, however. Frequently concern for discipline is linked with concern for the poorly motivated student.

Concern for health and physical fitness appears to be an area that has received attention by the states. The need for knowledge about health and health science topics has long been reflected in the science curriculum. Some of the recent science programs such as *Human Sciences* and *Me Now* reflect the increased attention to health, indicated as a need for education in general.

The needs briefly discussed here by no means constitute an exhaustive listing. Those needs focused on in the literature review were those appearing often and in a variety of sources and were assumed to represent the needs that appear to be those most urgently demanding attention. The needs of education are a subset of the needs of society. To study these is a task of extreme complexity.

Needs: Science Education

If the needs of education are a subset of the needs of society, then the needs of science education are a subset of the needs of education. Again, those which appear most critical, based on the literature review, will be discussed here. These needs for science education have been derived from legislation, from state educational policy guidelines, from reports of committees and conferences, from research studies and surveys, and, in some instances, from the broader educational needs identified earlier.

Stabilized and improved funding is a critical need in science education. The implications of decreased funding for science education are not yet, for the most part, well-documented in the litera-

ture. Discussions with personnel in various state departments of education revealed several problems stemming from reduced finances. First, and probably most critical, was the assignment of teachers to second and third teaching areas, either in addition to or instead of, their assignment to major areas of specialization. Such a situation would probably lead to lowered educational quality due to less-than-adequate teacher backgrounds. Second, increased class size has resulted from decreased finances. This poses a problem with safety in the science classroom, particularly if laboratory instruction is involved. Third, reduced funds available for purchasing equipment, materials and supplies affects the quality of the science program. Teachers have expressed increasing concern for the availability of lower-cost materials and for increased inservice education as budgets decrease.

Another problem involves small, rural schools and large urban school systems competing for the same basis for funding when they have quite dissimilar problems. Small schools, due to limited numbers of teachers as well as of students, typically offer fewer program alternatives than do large systems. In times of reduced budgets small schools may be disproportionately affected by losing some of the options they once had.

Yet another budgetary problem at the state level has resulted in the trend to eliminate many supervisory positions in the content areas and of altered assignments for state department of education personnel. State-level supervisors are now often operating out of their areas of specialization or, in some instances, generalists are now attempting to provide service in specialized areas.

The problem of funding for science education does not appear to be one that will be solved simply by channeling money into the educational system. An effective approach might be to establish the priorities or objectives for science education and then to fund the program accordingly. In trying to accomplish specific objectives, funding by categori-

cal programs appears to be more effective than funding by block grants.

The objectives for science education have remained relatively stable over the past twenty years. The basic and continuing need for science education appears to be for curricula that include (1) facts, concepts, and principles; (2) inquiry and investigative processes; (3) some emphasis on the interaction of science and society; (4) the development of appreciations and attitudes favorable to science; (5) career knowledge and awareness relative to science; and (6) relationships of self and environment.

Science curricula and instructional materials are needed that are more flexible, are appropriate for a wider range of student abilities, and that reflect emerging societal concerns.

To re-emphasize a concern expressed earlier in this literature review, there is a need for improved inservice education for science teachers. From a review of the literature, it is clear that the need for inservice education exists. What does not exist is complete agreement on what needs should be met by inservice program and how the programs should be constructed.

Continuing research in science education is vitally needed. Research which results in the identification of strategies that facilitate teaching or learning is needed, as is the application of research findings to teaching and learning. Because of the increasingly strong concern about declining achievement in science, as in other areas, research is needed which deals with some combination of factors identified as influencing this decline in scores. Regression analysis in which the amount of variance attributable to certain factors can be determined should be considered, to avoid unduly crediting or disregarding possible contributing elements. Also, care must be taken in interpreting existing research which does not indicate the amount of variance accounted for by reported factors.

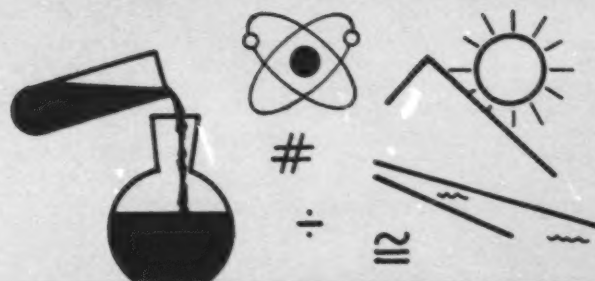
Equally important, the results of research in science education must be communicated to classroom practitioners if research is ever going to improve classroom instruction. Some successful ongoing mechanism(s) for this communication should be developed and put into action.

This is the first of four ERIC-SMEAC newsletters. Issue 2 will contain the summary of the mathematics education literature review.

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Summary of NSF Literature Review in Mathematics Education

This second issue of the ERIC-SMEAC newsletter is focused on the review of literature related to mathematics education which was a part of one of the three large-scale studies funded by the National Science Foundation. For those readers who might not have received the previous issue of this newsletter, the studies were (1) a nationwide survey of the public schools, coordinated by Iris Weiss, Research Triangle Institute, North Carolina; (2) a series of case studies of public schools and the communities they serve, conducted by Robert Stake and Jack Easley at the University of Illinois and others; and (3) a literature review, covering the period 1955-1975, conducted by personnel from the ERIC Clearinghouse for Science, Mathematics and Environmental Education and from the ERIC Clearinghouse for Social Studies/Social Science Education.

The purposes of the literature review were (1) to review, analyze, and summarize appropriate literature related to pre-college science instruction (for "science," read also mathematics and social science), to science teacher education, and to needs assessment efforts; and (2) to identify trends and patterns in the preparation of science teachers, teaching practices, curriculum materials, and needs assessment in science education for this twenty-year period.

The reviewers for the mathematics education portion of the project (Marilyn N. Suydam and Alan Osborne) focused on two questions: (1) What were and are current practices in mathematics education for curriculum, instruction, teacher education, performance of learners, and needs assessments during the twenty year period beginning in 1955? and (2) Was the information about practices used or ignored in decision-making concerning policy in education during the twenty year period?

Two recent publications had analyzed aspects of mathematics education: the 1970 yearbook of the National Council of Teachers of Mathematics, *A History of Mathematics Education in the United States and Canada*, as a source of information about events and practices for the first two-thirds of the twenty year period, and a 1975 report of the National

Advisory Committee on Mathematics Education, *Overview and Analysis of School Mathematics Grades K-12*, containing extensive information about more recent history in mathematics education. Suydam and Osborne searched for additional sources of information that would complement and up-date these publications.

Three major themes were treated in the mathematics education literature review: (1) *The Schools*—organizational, instructional and curricular patterns, as well as information concerning facilities, equipment, costs and student characteristics; (2) *The Teachers*—preservice and inservice education, as well as information concerning background, competence and behaviors; and (3) *Needs Assessment*—planning documents, systematic needs assessments, and progress assessments. Each theme served to organize a major section of the literature review.

Existing Practices in Schools

Practices in the schools were considered relative to an overview of activities in mathematics education during the past 20 years. This period has been one of continuing curriculum reform, with mathematicians and educators working as a team. Extensive federal funding has occurred, with federal policy increasingly affecting curricular development. The roles of federal agencies (National Science Foundation, Office of Education, National Institute of Education) have changed as these agencies have assumed varying degrees of responsibility for the cost of curriculum development and teacher retraining. During this period there has been a marked increase in research as well as in development efforts in mathematics education. There has been a concern for the mathematically able, especially at the secondary level, as well as a concern for the disadvantaged, especially at the elementary level.

The need for curriculum reform has been generated by different factors at different points in time. In 1955 the influential factors were public dissatisfaction with existing curricular outcomes and concern from mathematicians and mathematics educators for curriculum

reform. In 1965, important factors were the patterns of declining achievement scores, especially at the college entrance level, and pressures for accountability.

Organizational patterns. Educators are concerned with meeting the needs of individual students and increasing achievement. Many approaches have been tried (the use of mathematics specialists in elementary schools, team teaching, open classrooms, alternative schools, etc.). However, a review of relevant documents supports the finding that the graded, self-contained classroom at the elementary-school level and the fixed-period schedule of the secondary school have remained the predominant patterns over the past 20 years.

Authors of reviews of research have concluded that there appears to be no one organizational pattern which will increase student achievement in mathematics. Good teachers can be effective regardless of the nature of the school organizational pattern. However, researchers have given little attention to reasons why some teachers may be more effective with one pattern than with another.

Mathematics curriculum, content. As it is reflected in textbooks, curriculum guides, and descriptions of courses, the content of school mathematics curricula has changed over the past 20 years. In the elementary school, "arithmetic" has given way to "mathematics" in a curriculum that incorporates varying amounts of geometry, probability and statistics, functions, graphs, equations, inequalities, and algebraic properties of number systems. At the secondary level, a comparison of leading commercial texts revealed both change in emphases and inclusion of new content. "New math" has not been a single phenomenon. It has been series of developments that evolved and changed continuously.

Initially, curriculum reform focused on the college-bound student at the secondary school level, while most early elementary school projects developed supplementary materials. Changes in intent accompanied changing needs. Emphasis was placed on structure, rigorous deductive proof, exploration and correct

terminology, with changes in sequence and inclusion of topics. Methodological emphasis was placed on developing understanding.

As reflected in print, the content of school mathematics curricula changed. However, while the number and variety of courses offered at the secondary school level increased, inclusion of "new math" content in the elementary school may be illusory.

Curriculum guides vary in format and emphasis. They have little variance in content, with the impact of the California "strands" approach evident in many guides. Behaviorally-stated objectives distinguished many 1965-1975 guides from earlier guides. The need to disseminate information to increase implementation of new curricular ideas became apparent.

Since 1965, data clearly indicate that enrollment in secondary school mathematics courses has increased, especially in advanced mathematics courses. Thus, more students are studying more mathematics. A large percentage of students has studied materials developed by one or another of the curriculum reform projects. Enrollment patterns seem relatively stable in the 1970's, with continued small increases in advanced courses and in basic or remedial mathematics.

Mathematics instruction. Knowledge of what goes on in schools is limited. Few studies have described the actual class situation. However, some generalizations can be made relative to class size, time allotment and use, teaching approaches, and the differentiation of instruction.

Approximately 20 percent of the elementary school day is allocated to mathematics, with the number of minutes increasing with grade level. At the secondary school level, approximately 200-300 minutes per week are allocated to mathematics. A large portion of time is taken up by non-instructional activities (control, classroom routines, other managerial duties). How time is used may be of more importance than how much time is available. Higher achievement is likely to result when more than half of the time is spent on developmental activities.

Classrooms have changed little over the past 20 years, despite the innovations advocated. Predominant patterns continue to be: instruction with total-class groups, tell-and-show followed by seatwork at the elementary school level, and homework-lecture-new homework at the secondary school level; and the use of a single textbook but few other materials.

It appears that no one mode of instruction can be considered "best." Meaningful instruction promotes achievement, retention, and transfer—all accepted goals of instruction. Teachers believe

that activity-oriented instruction should be used. Few actually use it.

Teachers frequently do not differentiate instruction. They tend to gear instruction to skills already achieved by their students. Various means can be used to differentiate instruction, including grouping for specific needs. However, many teachers find it difficult to group for mathematics instruction.

There is little evidence that self-paced programs for individualized instruction are any more effective than "traditional" instruction. Most low-ability pupils find it difficult to function using self-paced programs. Such programs cost much more than traditional instruction. The disadvantaged student can profit from special attention, but such students differ individually more than as a group.

The needs of the talented are not being well-served in the 1970's. Enrichment programs are especially needed for those in small schools. Advanced Placement serves the needs of those who are going to use mathematics better than it does the needs of those who are going to major in mathematics. The Advanced Placement Program in mathematics requires that a school carefully design a curriculum that will accelerate students. The most successful schools begin the acceleration process early in the junior high school experience. The AP program does not work well in schools which have designed a program affording students AP opportunities only in the last year or two of secondary school.

Achievement evaluation. The role of evaluation continues to be important in the determination of educational policy. The scope and role of evaluation have greatly expanded during the 1955-1975 period. Evaluation information is now expected to provide guidance for programmatic decisions, whereas in 1955 its primary use was in terms of standardized tests and decisions concerning individual students.

Standardized tests have assumed increasing importance. Recognition that scores from tests are being misused has increased; many people still believe the important outcomes of schooling can be adequately appraised by achievement tests. The limitation of the use of tests for developing instructional outcomes is being emphasized by many leaders.

The greatest change in testing has been the increasing use of objective or criterion-referenced tests, such as behavioral objectives that were emphasized in the 1960's. At that time (1960's) behavioral objectives were an issue. In the 1970's there is less concern for the form of objectives and renewed concern for the intent of the objectives. Instructional objectives and test items compare favorably on content involving knowledge of computation, but not on content concerning geometry, mea-

surement, and other topics. Insufficient attention has been given to the testing of higher-order objectives (e.g., problem solving or analytic thought).

Student characteristics. Five characteristics were identified as the foci for discussion of relevant literature: aptitude, attitudes, self concept, sex differences, and socioeconomic status. Most of the research indicates that aptitude, as measured by intelligence tests, is highly correlated with mathematics achievement. There may be a general intellectual factor for ability in mathematics, but it is suggested that mathematical ability consists of a number of factors. Prior experiences, verbal ability, reasoning, and spatial ability are related to mathematical ability. The role of language, sex, age, and heredity needs further study.

Many people believe that mathematics is disliked by most students or, at the least, is not a favorite subject. However, research indicates that attitudes toward mathematics are generally positive in the elementary school and appear to peak at approximately age 12. There is limited evidence that attitudes toward mathematics were slightly more favorable in the 1960's than they were in the 1950's.

When reasons for liking or disliking mathematics are considered, several studies link dislike to frustration with word problems, possibilities of making mistakes, too many rules, and "not being good at" as reasons students identify for their feelings. Reasons for liking mathematics include the idea that working with numbers is fun and presents a challenge, that mathematics is logical, and that there is need for mathematics in practical living. Attitudes toward mathematics may vary with sex (results are not consistent). If there is a difference in attitude toward mathematics by boys and girls, this difference can probably be attributed in large part to a societally-induced expectation.

While mathematics educators and researchers believe that attitude toward mathematics is related to achievement in mathematics, there appears to be no meaningful or significant relationship between the two. Whether self concept is significantly related to mathematics achievement has not been definitively ascertained.

Sex-related differences in mathematics achievement are not universal across the factors related to mathematical ability. Differences in aptitude and achievement vary more with individuals than by sex. Girls and boys at the early elementary school level do not differ significantly in mathematical achievement. In upper elementary and early high school years, differences were not always apparent. When differences did occur, they

were likely to favor boys on high level tasks and girls on computation. No conclusions regarding sex differences can be reached concerning secondary school students. Fewer girls take mathematics, however. Socio-cultural factors appear to be involved. Societal expectations, which have changed in the past 10 years in terms of women's roles, do not seem to have produced changes at the secondary school level where peer inter-relationships are very important.

Socioeconomic factors appear to account for much of the variance in mathematics achievement. Evidence seems to indicate that socio-economic status and achievement in mathematics are correlated, but that the school has little hope of narrowing the achievement differential between socio-economic levels.

Instructional materials. Textbooks, supplemented by workbooks and other materials for seatwork or homework, are heavily relied upon in mathematics teaching. The textbook is the primary determinant of mathematics curricula. Many teachers use no instructional materials except the textbook and the chalkboard.

About half the states have mandated textbook adoption lists, with more states having multiple text adoptions than was observable 20 years ago. However, a single textbook is still used in most classrooms.

While there is variance across textbooks at the elementary school level, the basic components of the curriculum have become standardized, so that the variance is largely in terms of amount of space allocated to a topic, approach, and design. At the secondary school level, wider variance is obvious as the type of course varies. Teachers tend to follow the textbook closely with regard to content selection and sequencing, though they may skip or ignore components which they do not consider essential. Supporting the contention that the textbook influences what is learned is a report by Begle, published in 1973, identifying different patterns of achievement associated with the use of different textbooks.

Readability has been of specific concern for at least 10 years when textbook selection is considered. Between 1955 and 1964, the total vocabulary load in elementary school textbooks was reported to have increased by more than 40 percent. Some textbooks and project materials have been revised to prepare versions with more appropriate vocabulary and reading levels. The incorporation of research findings in textbook content has also been considered. When recommendations were clear, concise and exact, they were incorporated into many textbooks within five years. Since

the late 1950's some ideas have appeared in the majority of textbooks in less than five years.

Much discussion was focused on programmed instruction in the late 1950's and into the early 1960's, based primarily on the idea that programmed instruction would allow each pupil to progress at his/her own pace. The use of programmed instruction may save time in achieving specific goals but it is unclear whether pupils actually progress at individual rates.

When the use of manipulative materials is considered, several findings are obvious. In 1955, the primary grade teacher was more likely to use manipulative materials than were teachers at other levels. In the 1960's emphasis on the use of manipulative materials at all levels was emphasized. However, the 1955 pattern continues to be found in 1977 — the primary grade teacher is still most likely to use materials. Little use is reported at other levels. Although use of manipulative materials decreases as grade level increases, the use of such materials appears to be effective with certain content at all age levels and with all types of children.

In 1955, schools and computers were considered separate entities. Availability and cost prohibited a merger. In the early 1960's some schools bought or leased computers, or computer time, usually for administrative purposes, and eventually, for mathematics instruction. Since 1970 the fraction of secondary schools reporting some computing activity has steadily increased, from 34.4 percent in 1970 to 58.2 percent in 1975. Mathematics classes used the computer most frequently, although the percentage dropped from 46.7 percent to 43.2 percent. The problem solving mode was the most widely used, followed by simulation and then tutorial CAI.

When studies on the effectiveness of the use of computers were reviewed, results were, in general, equivocal. Higher general achievement was not a foregone outcome of the use of computers but they did aid in promoting problem-solving achievement. A review of studies related to drill- and- practice programs using CAI provided evidence that higher achievement could be anticipated when CAI was used to augment regular instruction.

Another instructional tool is the hand-held calculator which has been on the market since the early 1970's. The calculator, which decreased in price in 1975, has the potential to change the curricular focus on computation. A critical analysis of the literature related to hand-held calculators has resulted in the identification of reasons for, and against, their use.

Frequently cited reasons for using calculators included: aid in computa-

tion; facilitation of understanding and concept development; lessening of the need for memorization; help in problem solving; motivation; aid in exploring, understanding, and learning algorithmic processes; and the fact that hand-held calculators exist and are appearing in the hands of increasing numbers of students.

The most frequently cited reasons for not using calculators were that: they could be used as substitutes for developing computational skills, they were not available to all, and they might give a false impression of what mathematics is. The first concern was expressed most frequently by parents and other members of the public. Few educators, however, believed that children should use calculators in place of learning basic mathematical skills.

How extensively the calculator will influence the mathematics curriculum is unclear. Conflict is obvious between those who see computational skills as the most vital task for mathematics teachers and those who see the calculator allowing a change in direction — a change feasible for the first time in history. In the past three years, opinions have changed. The calculator is being used with increasing frequency, but the curriculum has not changed noticeably. Both short- and long-term research and curriculum development need to be undertaken, in addition to teacher-training efforts.

Instructional costs. Although it is virtually impossible to determine the actual amount of money spent for education (because of different figures and different bases), there is little doubt that both the costs of instruction and the amounts allocated to instruction have increased since 1955, over and above the inflation rate. For at least 15 years, education has been the largest item in the budgets of most state and local government. The amount of federal funding for education has increased dramatically.

The amount of money devoted to mathematics instruction is difficult to determine; 18 to 20 percent seems plausible but cannot be verified from available data. The amount of money spent per pupil has not been found to be significantly related to achievement in mathematics in most studies. There are indications that socioeconomic factors outside the control of the school exert a greater influence.

Assessments of the impact of federal funding show an increased emphasis, since 1968, on the evaluation of federally funded projects. The reports from those receiving funds almost invariably indicate that they feel the funded activity was successful. In few cases were there hard data or a controlled research design. Evaluation from outside reviewers rarely indicated the degree of success those involved in a project or activity reported.

Federal policies which conflict with local priorities were not likely to be fully implemented. Federal policy on evaluation of funding efforts can be implemented when public opinion coincides with federal need.

Existing Practices and Procedures in Teacher Education

Changes in the nature and quality of preservice and in-service education for both elementary and secondary school mathematics teachers have taken place during the 1955-1975 period. During the 1955-1965 period in-service education was the focus of attention and action. The attention accorded in-service teacher education was so consuming that the majority of conclusions to be made about preservice education are inferential and based on information collected relative to in-service needs.

Discussion sections related to teacher education were grouped by ten-year periods (1955-1965 and 1965-1975), but some generalizations can be made which span the twenty-year period. The mathematical background of students completing preservice programs for elementary and secondary school teachers increased significantly during the two decades, with the character of that mathematical experience reflecting the current curricula in the public schools. Teachers are acquiring a second professional degree in greater percentages and at an earlier age than ever before.

The history of in-service education, especially at the secondary school level, during the 1955-65 era is highly related to the history of the National Science Foundation's development of in-service programs. The NSF institutes reached an estimated 35 percent of the mathematics and science teachers. The massive sponsorship and support of in-service education provided by the federal government during the 1950's and 1960's changed the expectations of teachers about in-service education. In-service education as supported by NSF had paid teachers' fees and living expenses. The mathematics and methods were "packaged" for the teacher by the institution of higher education providing the NSF institute. Institute programs were primarily disciplinary in orientation (a typical summer institute was about 80 percent mathematics and 20 percent teaching methods). This situation had several consequences: teachers, accustomed to having work prepackaged by an institution of higher education, lacked skills for identifying needs and planning in-service to fit those instructional and curricular needs. They came to expect that not only would in-service work be designed for them but, it would be provided and paid for by someone other than the teacher or the school system.

During 1962-1965, the three peak years of financial support, the level of federal investment in in-service education was approximately \$37,000,000 per year (equivalent to approximately 70 million dollars in 1975 dollars). However, in 1975, no funds were available for teacher institutes for the coming year. Teachers' expectations and attitudes about in-service education, built over a twenty-year period, were upset as were the roles and functions that school systems and institutions of higher education had established. For a period of time this traumatized the mathematics education in-service effort.

However, teachers want in-service education. They prefer that it be related to programmatic and instructional needs in their schools. Teachers also prefer in-service education that is neither purely mathematical nor purely methodological. Leadership at the local school level can appreciably change the character of in-service education and teachers' perception of its worth.

Information gained from an In-service Project of the National Council of Teachers of Mathematics indicates that the critical factor in determining teachers' perceptions of the effectiveness of in-service education is the extent to which planning is participatory. If teachers' judgments of need are incorporated into planning a program fitting their curriculum and their instruction, they were significantly more likely to feel their in-service experiences were satisfying.

The majority of elementary and secondary school mathematics teachers who responded to the In-service Project survey indicated that topics of a purely mathematical nature were not as popular as those incorporating aspects of the teaching and learning of mathematics. Teachers prefer released time for in-service activities, but only 44 percent of the elementary respondents and 39 percent of the secondary respondents reported that their schools can or do provide this.

Many teachers attain their second degree before they have had 10 years of teaching experience and indicate a strong perception of need for further in-service activities throughout their remaining 25 to 35 years in the teaching profession. However, little evidence exists that in-service education makes a difference in children's learning. Studies addressing this problem are few and far between. Research evidence is, however, supportive of in-service education making a difference to teacher content backgrounds.

Competence of teachers, when assessed in terms of promoting mathematical growth in their students, is apparently related to a complex interaction of an assortment of factors rather than being simply related to a limited number of factors in linear combination. Mathematical

background and attitude toward mathematics as characteristics of teachers do not account for a substantial amount of the variance in the performance of the teachers' students.

When preservice teacher education is considered, five major developments of the 1965-1975 period are obvious: (1) an increase in mathematics requirements for secondary and elementary programs, (2) competency-based teacher education, (3) an increase in the amount of pre-student teaching field experience, (4) the incorporation of an emphasis on laboratory and/or activity learning into the teacher education program, and (5) the supply and demand factors in the prospective teacher population.

Competency-based teacher education does not appear to be a significant factor of sustained impact on teacher education programs, at least for the immediate future. Computer literacy and the background to use the computer in the teaching of mathematics is not a component of certification requirements in most states or in the institutions that prepare teachers.

The most significant trend in teacher education at the preservice level is the move toward incorporating pre-student teaching field experience in mathematics education as a major modification in program design. This trend is being accomplished because it seems "sensible" rather than because its effects on the prospective teacher are known or verified. Few studies in this area have been reported. Almost no direct evidence of the effects of early experience in the schools or of what, or how, it contributes to a total program in teacher education is available. It is not known what constitutes sound pre-student teaching field experience or what does not. This is a major area for needed research in mathematics teacher education since cost figures for such programs are appreciably higher than for traditional teacher education programs.

There is a significant trend toward including laboratory or activity learning emphases in both the mathematical and the methodological phases of prospective elementary teachers' academic preparation for teaching. This trend is related to another development: the integration of the mathematics and methods course content. The impetus for this development stems from the belief that teachers teach as they were taught. The need for better working relationships between mathematics departments and methods teachers in education faculties keeps such integration from being labeled as a trend.

Between 1955 and 1965 there was a shortage of teachers. During the 1965-1975 period, the supply factor changed markedly. However, evidence suggests that the oversupply of secondary

teachers in particular may rapidly give way to undersupply in the near future. Significantly fewer freshman-level students are indicating teaching as a career choice. There are no projections of teacher supply and demand factors that are specific to secondary school mathematics.

The reviewers found no firm data concerning the number of mathematics teachers serving in the schools at the secondary level nor how many undergraduate majors in mathematical sciences were certified for teaching. Supply and demand data for secondary mathematics teachers appeared to be nonexistent.

Needs Assessment: Mathematics Education

In 1955 needs assessments were conducted, largely in an informal matter. Needs were assessed in terms of a particular purpose, used for that purpose, and not necessarily preserved once the purpose had been achieved. Reflections of needs were evident in a variety of sources, including journal articles, conference reports, legislation, committee recommendation, guidelines; trend analyses, and achievement test data.

For purposes of the review, a differentiation was made between "needs assessment" and "progress assessment." "Needs assessment" was used to refer to literature involving goals; "progress assessment," to that referring to achievement and other status test data. Within each of these divisions, studies and other documents were classified as relating to national concerns or to state concerns.

Needs assessment: national concerns. Needs which have been repeatedly discussed and cited include the need to: (1) examine mathematical goals in relation to societal needs; (2) examine implications of technology, including computers and calculators; (3) establish minimal competencies (as a basis for accountability); (4) restructure the curriculum (to resequence, extend, enrich or one or another specific purpose); (5) increase attention to applications, statistics and probability, problem solving, the metric system, and basic mathematical skills; (6) provide for individual needs, particularly of less-able pupils and the talented; (7) improve articulation of mathematics with other subjects and across grades; (8) conduct research on the learning of mathematics, link research and curriculum development, and improve the implementation of research; (9) improve pre- and in-service teacher education to strengthen teacher competency, both in knowledge of content and methods of teaching; (10) develop better evaluation techniques; and (11) improve cooperation between mathematics educators in universities and schools.

Discrepancy in the selection or ranking of goals — between educators and the public, college personnel and classroom teachers, students and teachers — is not uncommon. However, it can be of particular concern when the rankings of educators and taxpayers are widely divergent. Thus, in the 1970's, there is a discrepancy between public concern for "the basics" and educators' concern for "mathematical understanding."

Recently (1976) mathematics educators, department heads, and supervisors were asked to comment on future events that could have implications for mathematics education and to generate consensus on what should receive priority in light of this envisioned future. The events considered most important were (1) back-to-the-basics movement; (2) continued acceleration in computer technology; (3) increasing complexity of our society; (4) continued demand for relevancy in mathematics; (5) an increase in community involvement in schools; and (6) increasing demand for school accountability, both in programs and expenditures.

The curriculum priorities deemed most important or desirable were: (1) mathematics should involve more activity learning; (2) mathematics should involve more use of computers and calculators; (3) real applications (some involving metric dimensions) should illustrate the utility of mathematics; (4) more emphasis should be placed on developing creative thinking in and via mathematics; (5) probability and statistics should receive more emphasis in school mathematics programs; and (6) the mathematics curriculum should be continually revised and updated to conform with the present and future need of the students.

Needs assessment: state concerns. In most of the documents reviewed from individual states, mathematics concerns were either not cited or were only one of several, or scores of, concerns cited. In relatively few states were specific documents available on planning for mathematics education. As far as can be determined from the documents surveyed, the main identified concerns did not differ from those at the national level. Slight differences in priorities were found.

While mathematics education per se is seldom cited in state goals, it is most frequently one aspect of a "competency in basic skills" goal. Where needs assessments specific to mathematics have been conducted, both "knowledge of basic skills" and "applications of skills to real-life problems" have been high on the list of needs. As at the national level, discrepancy among concerned groups was apparent in the priority assigned to mathematical goals.

Progress assessments: national level. Within the twenty-year period of the literature review, comparisons of "new" and "traditional" mathematics programs focused attention on the need to develop more appropriate means of assessment. The National Longitudinal Study of Mathematical Abilities (NLSMA) was the first large-scale testing program in mathematics and involved the School Mathematics Study Group (SMSG) materials. Although the NLSMA was not primarily concerned with assessment, many of the procedures parallel those used in later assessments. Conceived as a study of the effects of various kinds of mathematics textbooks on the learning of mathematics, NLSMA focused attention on the need for longitudinal assessment and improved evaluation techniques.

The National Assessment of Educational Progress (NAEP), conducted by the Education Commission of the States, began assessment of various subject areas in the late 1960's. The first mathematics assessment by NAEP was conducted during 1972-73; the second, 1977-78. The assessment included six major content areas: numbers and numeration, measurement, geometry, variables and relationships, probability and statistics, and consumer mathematics. NAEP data have indicated specific strengths and weaknesses, although the primary function of NAEP is to provide longitudinal information on the status of mathematical achievement.

Another assessment conducted in the 1960's was the International Study of Achievement in Mathematics (IEA mathematics). This survey involved 133,000 students in 5,450 schools in 12 countries. Thirteen year-olds and pre-university students (grade 12) were sampled. Although IEA has provided data on the achievement of American students compared with students in 11 other countries, the results are difficult to interpret in view of the many varied cultural and school factors involved.

A comparison of computational skills data from NAEP, NLSMA, and several other assessments indicated that these skills are not acquired on the basis of initial instruction but that performance tends to stabilize during the junior high school years. Stabilization occurred earlier for whole-number examples than for those with fractions. Level of performance decreased as items became more complex.

College-entrance and some other standardized test scores have indicated declines in achievement across the years, with more extensive decreases for verbal portions than for mathematical portions of the tests. Causes for the drop in achievement levels have been hypothesized and involve both the school and the home. Some writers be-

lieve the school-related causes can be more closely studied and more easily influenced. School-related factors whose developments closely parallel the decline in the achievement scores seem to be: (1) high school students taking fewer "basic" courses (e.g., English, mathematics) and fewer college preparatory courses (algebra, first-year foreign languages, chemistry, physics), (2) increasing numbers of students absent from school, and (3) fewer students dropping out, resulting in a larger percent of drop-out prone students taking tests.

Progress assessments: state level. Again, the document base in terms of state-produced documents was not extensive. However, the movement toward accountability has resulted in both minimal competency requirements and assessments of achievement in many states. As of April 1977, eight states had minimal competency legislation, 10 had state board of education rulings, and legislation was pending in 10 more states. As of June 1974, 30 states had accountability legislation which took varied forms: state assessment/evaluation, state testing programs, modern management techniques, professional personnel evaluation, performance-based school accreditation, and performance contracting. Reporting procedures varied widely for these 30 states, as did the scope of objectives and type of test involved.

The content areas for which weaknesses were identified are ones which have been known to be difficult. Fractions, division, and subtraction with regrouping head the list, which also includes decimals, geometry, measurement, proof, estimation, statistics and probability, and problem solving.

In Conclusion

Suydam and Osborne conclude the mathematics education portion of the twenty-year literature review with the identification of some major deficiencies they found for the process of policy formation as they examined the record and commented on those deficiencies.

They concluded that the evidence shows that progress and change have been the result of federal intervention into the domain of mathematics education. Some writers claim that federal investment in mathematics education has often been the vital margin determining whether a change would be realized or not. There is little evidence that the future will be otherwise.

To Suydam and Osborne, three primary sources of difficulty or failure in the processes of policy formation for mathematics education are apparent from the recent history of mathematics education. One, educational policy is frequently determined without collecting enough information to allow the process to be rational. Two, educational policy is frequently constructed without using in-

formation that is readily available. Three, the point at which values enter into policy formation and the effects of the differences in the values held by various groups concerned with the schools is frequently not recognized in determining the priorities within educational policy.

Relative to the first type of difficulty, several examples are cited relative to practices in the schools and to practices in teacher education. Classroom practices of teachers are largely undocumented. Little is known about the extent to which teachers differentiate instruction for children with different characteristics and needs. Not enough is known about the extent and nature of teachers' use of instructional materials and tools. The extent of teachers' dependence on drill-and-practice teaching strategies is not known. Data concerning supply and demand of secondary mathematics teachers are only conjectural. Little evidence is available concerning the characteristics of the small but significant portion of teachers refusing to participate in in-service activities and/or about program characteristics that may keep them from participating. More evidence is needed about how much, what kind, and when early field experience should be a part of a teacher education program or how this actually contributes to developing teacher competency. The characteristics of teachers that contribute to the effective learning of mathematics by students are not well-described nor verified.

Failures of the second type (policy formation without using available knowledge) are also readily apparent. The formulation of policy has frequently not recognized that some characteristics of performance and practice appear to have significant stability over the years. This may be evidence of a lack of information dissemination, failure to do sufficient summative literature analyses, or simply testimony to the youth of the field of mathematics education and its resulting lack of academic traditions.

The third type of failure or difficulty, that of not recognizing the point at which the values of various groups enter into policy formation, is also quite evident. It has been pointed out that change has little permanence in the schools if the need for a project or problem is based on an entrepreneurial motivation rather than on a perception of a problem in need of solution by the primary personnel of a project. A development or research effort will fail at the point of implementation or application of the results if discrepancies are not resolved.

The problem for professionals appears to be a matter of efficiency in promoting change. Not only must professionals collect appropriate kinds of information concerning practices in the schools, they must also make sound application of this information.

New CIJE Publisher

Beginning with the March 1979 issue, *Current Index to Journals in Education* has been published by Oryx Press, Phoenix, Arizona. Subscribers to *CIJE* should contact Oryx Press, if they have not already done so, to avoid undue delay in receiving the publication. For subscription information, contact:

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Produced by the ERIC Clearinghouse on Educational Management, University of Oregon (Eugene), this volume contains summaries of 307 reports and journal articles. The publication covers issues 21 through 40 of "The Best of ERIC" series produced by the Clearinghouse on Educational Management. This series focuses on 20 topics of current interest to school administrators. The topics included are:

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The Best of the Best of ERIC, Volume 2 is available at \$6.50 per copy, prepaid (purchase orders accepted). Requests should be sent to:

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Recent Publications from ERIC-SMEAC*

Science Education

Selected Science Activities In Consumer Decision Making. Richard L. and Rebecca L. Sagness, editors. \$3.00. ED 162 895

This publication contains many science education activities related to consumer decision making. Each activity has been classified by the editors according to the most appropriate grade level, the area of consumer education involved, the specific topic, and the consumer education concept considered. Areas involved are the consumer and the environment, foods, advertising, tools, health, clothing, product testing, and natural resources.

Science Education/Society: A Guide to Interaction and Influence, 1979 AETS Yearbook. Michael R. Abraham, editor. \$7.50. ED 164 360

The topics identified in this yearbook are issues which go beyond the content of science or methodology of science teaching. An attempt is made to discuss the influence of society on both science and science teaching as well as the influence of science teaching on society. Topics and issues are grouped under three headings: Science Education and Its Influence on and Interaction With Society (energy, population and people, pollution, natural resources, human behavior, sex education, genetic issues, parapsychology, astrology, creationism, drugs, technology); Society and its Influence on and Interaction with Science Education (two decades of curriculum projects, theory in curriculum and instructed learning, influence of funding by the United States government on the teaching of science in the elementary and secondary schools, the influence of professional associations on science teaching, special student needs — science for the handicapped, career education); and Influence and Interaction Between Science Education and Society (exploring value issues in science teaching; science, mind and education, the essence of life, bringing about change in science education).

National Association for Research in Science Teaching 52nd Annual Meeting, Abstracts of Presented Papers. Arthur L. White, ed. \$3.50. SE 026 771

This publication contains abstracts of papers presented at the fifty-second annual meeting of the National Association for Research in Science Teaching (NARST), Atlanta, Georgia, March 21-23, 1979. These papers relate to science

teacher education (pre-service and in-service), cognitive development, learning, instruction, teacher and student behaviors, research design, and other topics.

Mathematics Education

Perspectives on Women and Mathematics. Judith E. Jacobs, editor. \$5.00. ED 166 051

The core of this monograph is composed of papers presented in the strand on "Women and Mathematics" at the 1978 annual meeting of the National Council of Teachers of Mathematics. The publication also contains two commentaries which synthesize the material presented at the San Diego meeting and which offer additional suggestions for action. These papers serve as a vehicle for sharing the best thinking available on the problem of changing the rate of participation of girls and women in the study and use of mathematics.

Selected Research Papers, National Council of Teachers of Mathematics National Conference, 1979. Jon L. Higgins, editor. \$2.25. ED 167 383

This is a collection of abstracts of selected papers presented in the research reporting sections of the 1979 annual meeting of the National Council of Teachers of Mathematics, Boston, April 18-21. Topics reported include use of hand-held calculators, problem solving, use of games, and cognitive processes and mathematics learning.

Resources for Teaching Mathematics in Bilingual Classrooms. C. James Lovett and Ted Snyder, eds. \$1.75. SE 027 515

The purpose of this report is to provide, in one document, a substantial resource for those concerned with mathematics teaching in bilingual programs. Part I of the report provides an overview of the issues and problems involved. Part II consists of an annotated bibliography of materials for teaching mathematics in Spanish/English programs. A list of suppliers of bilingual mathematics materials, a list of references to general bilingual materials, and a phrase list are appended.

Environmental Education

Current Issues in Environmental Education-IV: Selected Papers from the Seventh Annual Conference of the National Association for En-

vironmental Education, Craig B. Davis and Arthur Sacks, editors \$5.00. ED 167 407

Included are 31 of the 73 papers presented at the 1978 conference of the National Association for Environmental Education (Chicago, April 30-May 2). The papers are organized into seven sections: environmental ethics, international environmental education, energy systems, environmental studies, environmental education research, and environmental education programs.

Energy Education: A Bibliography of Abstracts from RESOURCES IN EDUCATION (RIE) from 1966-1978, compiled by Milton Rinehart, Robert W. Howe, and M. James Kozlow. \$5.00. ED 166 067

The total RIE data base, 1966-1978, was searched for materials of use in energy education. Resumes of 514 documents are presented. Also included are Subject, Author, and Institutional Author Indexes.

Energy Education: A Bibliography of Citations from CURRENT INDEX TO JOURNALS IN EDUCATION (CIJE) from 1966-1978, compiled by Milton Rinehart, Robert W. Howe, and M. James Kozlow. \$5.00. SE 026 992

The total CIJE data base, 1966-1978, was searched for articles of use in energy education. Citations of 899 articles are presented. Also included are Subject and Author Indexes.

Environmental Education in Action-III: Case Studies of Public Involvement in Environmental Policy. Selected and edited by Clay Schoenfeld and John Disinger. \$5.50. SE 027 517

Twenty-seven case studies, gathered from across the United States and into Canada, dealing with "non-formal" environmental education are presented. These range from activities of conservation-oriented organizations to "grassroots" responses to environmental concerns.

Alliance Affiliate Activities: Non-Governmental Organizations in Environmental Education. John S. Disinger, ed. \$3.50. SE 027 518

The 32 member organizations of the Alliance for Environmental Education, a national umbrella group of private organizations maintaining interest in environmental education, each contributed a report of their environmental education activities, concerns, and agendas. Also included is a report of the activities of the Alliance.

* Ordering information on next page

PUBLICATION ORDERING INFORMATION

Readers wishing to order a copy of any of the publications described on the preceding page have several options. They may contact the ERIC Clearinghouse for Science, Mathematics and Environmental Education and order directly from the Clearinghouse, at the prices quoted on page 7. They may also purchase the publications from the ERIC Document Reproduction Service (EDRS), P.O. Box 190, Arlington, VA 22210. Materials ordered from EDRS may be purchased as microfiche or papercopy. Prices for microfiche or papercopy are quoted in the document resumes in *Resources in Education* (RIE.) (Ordering information is found in the back pages of each issue of RIE.) Microfiche copies of documents usually cost 83 cents (\$0.83), plus postage and handling charges. Papercopy price varies with the length of the document. Materials are ordered from EDRS by specifying the ED number of each document.

Some of the ERIC-SMEAC publications listed on page 7 do not have ED numbers. Instead they are identified by SE numbers. These materials have been sent to EDRS for inclusion in future issues of *Resources in Education*. When documents are announced in RIE, each will have an ED number in addition to its SE number.

Readers wishing to order the science education portion of the literature review, described in the previous issue of this newsletter, may order it from the Clearinghouse for \$7.15 or from EDRS as document ED 153 876. Volume 4, the mathematics education portion of the NSF literature review, is also available from the Clearinghouse for \$7.15 or from EDRS as document ED 153 878.

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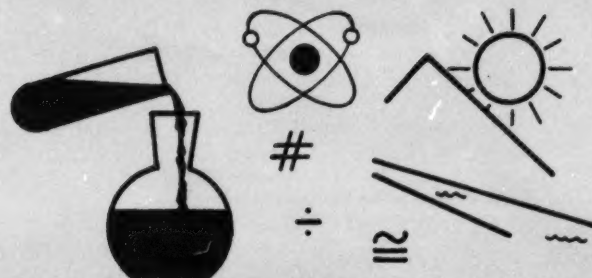
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National Assessment Studies Energy Education

The third issue of the ERIC-SMEAC information bulletin is focused on topics and issues related to environmental education. One of the major concerns related to the environment is energy, its sources and problems related to energy production. This issue contains some information about energy knowledge and attitudes of the American public as these data have been obtained from a survey conducted by the National Assessment of Educational Progress (NAEP), The Education Commission of the States, Denver, Colorado.

One of the sources reviewed is *ENERGY Knowledge and Attitudes, A National Assessment of Energy Awareness Among Young Adults*, Report No. 08-E-01, December, 1978. This document is available from the ERIC Document Reproduction Service (EDRS) as ED 166 017. Other sources are *Science Achievement in the Schools*, December, 1978 (ED 164 337) and *Three Assessments of Science 1969-77: Technical Summary*, April, 1979. Persons interested in ordering the summary should check the August issue of *Resources in Education* (RIE) for the ED number of the technical summary.

Also included in this issue of the information bulletin are descriptions of some ERIC Clearinghouse for Science, Mathematics and Environmental Education publications relating to energy and other aspects of environmental education.

Since 1969 the National Assessment of Educational Progress (NAEP), funded by the U.S. Office of Education, has been systematically monitoring the nation's progress in education. The activities of NAEP are in response to a charge first set before the Office of Education in 1867. However, it was not until 1969 that systematic efforts were carried out to collect data that would report on the nation's progress in education in terms of knowledge, skills and attitudes. Yearly surveys are conducted, involving American 9-year-olds, 13-year-olds, 17-year-olds and young adults (ages 26 to 35). At present ten learning areas are being assessed: art, career and occupational development, citizenship, literature, mathematics, music, reading, science, social studies, and writing.

Although energy assessment was not one of the original areas to be assessed, problems with energy use and availability are such that this topic appeared to merit study. If citizens are not adequately informed about energy, they are not able to make wise decisions. Energy problems affect not only government, business, commerce, and foreign policy — they affect individual lifestyles. Therefore, National Assessment staff and persons with expertise in energy-related areas met to identify some goals and objectives of energy education, preparatory to surveying the American public's knowledge about energy.

The Survey Instrument

After goals and objectives were identified, questions were developed. These questions were then reviewed by scientists, science educators, and energy experts. Seventy knowledge questions and 76 attitudinal questions were used. Questions measuring knowledge were categorized as relating to (1) basic energy facts, (2) general energy issues, and (3) energy conservation. Questions measuring attitudes were categorized as focusing on (1) feelings about the seriousness of energy problems, (2) belief in the effectiveness of personal action, (3) feelings toward environmental hazards, and (4) feelings toward energy trade-offs. This survey was given to a sample of American adults during the summer of 1977.

The Sample

A national probability sample of young adults, aged 26 through 35, was drawn. This sample was stratified by region and community size. Approximately 1300 adults responded to each question in the energy assessment.

Of this sample, 46.6 percent were male; 53.4 percent, female. Fifty-four and eight-tenths percent were in the 26-30 year group in age; 45.2 percent, 31-35 years old. When race was considered: 13.1 percent of the sample was black; 81.2, white, with 5.8 percent characterized as "other." In terms of community size, 38.5 percent were from big cities and their urban fringes; 61.5 percent, from medium and smaller cities (population less than 200,000).

The sample was also characterized according to educational level: 8.5 percent had not graduated from high school, 30.1 percent were high school graduates, and 51.3 percent had some education beyond high school. Such education may have involved business, professional or trade school training as well as college or university education.

Income (before taxes and deductions) was also considered: 17.4 percent of the sample had incomes below \$8,000 to \$14,999, 42.1 percent earned incomes of \$15,000 and above, and 6.1 percent were identified as giving "other responses."

The Results

The results of this assessment are reported in "Energy Knowledge and Attitudes, a National Assessment of Energy Awareness Among Young Adults," Report No. 08-E-01, published by the Education Commission of the States in December 1978. Emphasis throughout most of the report is on the national results although group results are also reported according to sex, race, total household income, community size, education, and age.

Differences between group and national results are discussed only when results appear to be significantly higher or lower than the national percentages of correct responses. Only differences statistically significant at the .05 level are discussed. Using the .05 level of significance means there is only a 5% chance that these differences are an artifact of the survey design or the sample.

Findings from the Energy Survey

Knowledge of Energy Facts, Issues, Conservation

Within the broad categories of energy facts, issues confronting American citizens, and conservation techniques were included such topics as energy demand and supply, energy use in various sectors of society, processes of energy conversion, major potential sources of energy, and social and environmental implications stemming from the current (summer 1977) energy dilemma.

In considering the responses of the adults surveyed, the reader should keep in mind that America with about six per-

cent of the world's population, consumes about 30 percent of the world's available energy. The average American citizen consumes approximately seven times the average amount of energy consumed by other world citizens, according to information in "Energy Conservation in the Home" (a publication of the U.S. Department of Energy, 1977, p. 21).

Results related to questions about knowledge of basic energy facts were mixed:

- 1) 67 percent knew that solar energy is the largest potential source of energy
- 2) 79 percent knew that petroleum is the largest export from the Middle East;
- 3) 70 percent knew that the United States is likely to run out of petroleum before it runs out of coal, but
- 4) only 16 percent knew that coal, as well as petroleum, can be converted to gasoline

If events at Three Mile Island had occurred in 1977 rather than 1979, results relating to nuclear power might have been different. In 1977 young adults knew little or understood little about the conversion process underlying conventional nuclear reactors. Only 17 percent correctly answered two parts of a three part question dealing with nuclear power.

Performance related to units of measuring energy was generally high. An exception was the acronym BTU (British Thermal Unit) for the engineering unit of heat energy used to designate the amount of heat necessary to raise the temperature of one pound of water one degree Fahrenheit. Some responses to energy measurement questions were:

- 1) 75 percent knew electricity is measured in kilowatt hours
- 2) 84 percent knew the rate at which a light bulb uses electrical energy is expressed as watts
- 3) 90 percent knew energy content of food is expressed as calories
- 4) 50 percent knew the heating value per pound of coal is expressed as a BTU or Calorie

Results related to questions designed to test knowledge of fossil fuels showed that:

- 1) only 49 percent knew coal is the largest fossil fuel reserve in the U.S.,
- 2) 40 percent responded "I don't know" to a question asking them to select from a list of by-products those which did not use a fossil fuel as a raw material, and
- 3) only 14 percent knew that coal is the primary energy source used to produce the largest portion of

our electrical energy. (Thirty percent believed falling water was the primary source.)

When the potential energy of a primary fuel is converted to a kinetic form so that it can be used, some of the energy becomes less useful and is thus lost for all intents and purposes. This loss is particularly serious in heat emitting engines and no engine can ever be 100 percent efficient, according to the laws of physics. However, 50 percent of the sample marked as correct the item "Improved technology will eventually make it possible to convert to useful work all of the energy released by burning a fuel."

Fifty-two percent knew that industry was the sector of society that consumes the largest portion of the nation's total energy (as compared to transportation, commercial and residential sectors). When given a question about the time required from beginning construction to production at various energy sites, only 14 percent correctly responded to at least three parts of a five-part question. Public knowledge about the time required for making an energy site operable and productive seems rather low.

In terms of general energy issues:

- 1) less than half (46 percent) of the sample knew that crude oil provides the largest percentage of energy consumed in the U.S.,
- 2) exactly 50 percent knew that from 30 to 60 percent of the oil consumed by Americans is imported from foreign countries,
- 3) 47 percent did not know that waste heat is emitted by nuclear power plants as well as by fossil fuel plants,
- 4) almost 50 percent did not know that the sulfur content of the coal deposited in the Western United States is less than that of the coal found in the Eastern U.S., and
- 5) 95 percent knew that automobile emissions contribute heavily to air pollution; 76 percent knew that oil tankers can contribute to water pollution.

When questioned about knowledge of federal monies used for research and development, ownership of power plants and terms associated with the energy problem, responses from young adults varied:

- 1) 50 percent knew that the federal government has allocated more funds to nuclear research and development than to coal, petroleum, solar, wind or hydroelectric research and development during the past 20 years;
- 2) 70 percent knew that, during the past 25 years, the federal government has spent less to improve rail transport than air or highway transport;

- 3) 70 percent knew that most electricity is produced in power plants owned by utility corporations (as opposed to major oil companies, the federal government, or cities and towns); and
- 4) almost 70 percent knew the meaning of the term "embargo," 50 percent knew what OPEC meant, and 50 percent knew the meaning of GNP.

Energy conservation may be accomplished by either curtailing energy supplies or increasing efficiency in the use of energy. Curtailment is normally short-term strategy used to cope with acute shortages. The NAEP energy instrument contained questions about energy conservation which had implications for the average person's home and transportation.

Results related to questions about home energy conservation included:

- 1) 55 percent knew that an electric clothes dryer consumes more energy in 15 minutes of continuous operation than does a color television, vacuum cleaner, dishwasher, or washing machine;
- 2) only 23 percent knew that heating water consumes more energy in the average American home in a year than refrigerating or cooking food, drying clothing, or lighting the home;
- 3) 71 percent knew that a 40-watt fluorescent tube produces more light than a 40-watt incandescent bulb for the same amount of electricity;
- 4) 65 percent knew that installing 6 inches of insulation in an insulated attic saves more energy than weather-stripping or caulking doors and windows, turning off lights when not needed, or closing fireplace dampers; but
- 5) only 29 percent realized that home consumption accounts for just one-fifth of the total energy consumed each year in America, even though 50 percent had correctly answered another question indicating that industry accounted for the largest portion of total energy consumed each year.

Only 19 percent of the sample knew four conservation methods that can result in significant savings: (1) in winter, set thermostat at 68° during the day and 60° at night; (2) turn air conditioner off when home is unoccupied for more than two hours; (3) set air conditioner at 78° rather than 72°; and (4) set hot water heater thermostat at 140° rather than 150°F.

The fact that young adults' knowledge about energy conservation in personal transportation contained some gaps was shown by responses to a series of questions about conservation techniques for automobile owners and driv-

ers. Only 61 percent knew that turning off the engine when the car is stopped for only 5 minutes saves gasoline. Thirty-three percent thought that keeping tires slightly underinflated for better traction either saves gasoline or has no effect on the amount of gasoline consumed, neither of which is correct. Only 46 percent knew that using radial tires saves gasoline. However, 87 percent did know that accelerating very quickly to the appropriate speed wastes gasoline.

Thirty percent knew that the average automobile gets the most miles per gallon of gasoline at 40 miles per hour rather than at 15 miles, 55 miles or 75 mile per hour. Fifty-five percent knew that the weight of the car has a greater effect on the amount of gasoline used than does the amount of air pressure in the tires, kind of gasoline used, cleanliness of the oil filter or of the spark plugs. Fifty percent knew that trains require less energy to move one ton of weight per mile than do trucks, airplanes, or helicopters.

Overall, young adults' performance was higher on conservation techniques in personal transportation (58 percent) than on conservation techniques in the home (54 percent). More males than females responded correctly. More whites than blacks responded correctly. More people reporting a household income of \$15,000 or above gave correct responses than from other income groups.

The summary portion of this section of the report is interesting in that it contains (pp 12-14) items grouped by percent of respondents answering correctly; categories are 19%, 20-39%, 40-59%, 60-79%, 80-100%.

Six items were answered correctly by only 19% of the respondents:

- 1) coal can be converted to gasoline;
- 2) the largest portion of our electrical energy is produced from coal;
- 3) five years are required to get oil fields and underground coal mines into production and 10 years to get nuclear power plants into production;
- 4) fission is the process currently used as a means of generating nuclear power for useful purposes;
- 5) fission and fusion create radioactive waste by-products; and
- 6) during the decade 1960-70, growth in the use of coal was greater than the rate of population growth.

The six items answered correctly by 80 to 100 percent of the sample were:

- 1) turning down the thermostat to 68° during the day and 60° at night results in significant savings

- 2) automobiles are commonly associated with air pollution rather than with water or heat pollution,
- 3) accelerating very quickly to the appropriate speed wastes gasoline,
- 4) car pooling to and from work with one other person for 50 miles saves gasoline,
- 5) the rate of electrical energy used by light bulbs is expressed in watts, and
- 6) the content of food energy is expressed as calories.

Attitudes About Energy Problems

Our current energy problems result from historical trends in the use of resources. Our country's needs for energy were first met by the use of wood. In the 1880's coal was more widely used than wood because improvements had been made in mining technology and coal was in plentiful supply. Since 1950 oil and natural gas have been the major sources of energy because they are cleaner, cheaper and easier to extract, transport and burn. By 1977, oil and natural gas provided 74 percent of the total energy needs of this country, coal — 19 percent, and hydropower and nuclear sources — 7 percent.

The population of the United States increased by 34 percent from 1950 to 1970, but per capita energy consumption increased by 46 percent. Energy use in 1970 was nearly double that in 1950. If this trend continues, America's annual use of energy per capita will have doubled again by 1990 so that we will have used as much energy between 1970 and 1990 as we used in all the years preceding 1970 (pp. 15-16).

People need to begin making choices for the future. To get some information about what these choices may be, items were designed to obtain information about attitudes about (1) the seriousness of the energy problem, (2) personal actions that relate to the energy situation in America, (3) environmental hazards associated with the development of energy sources, and energy trade-offs. One group of questions was designed to determine if young adults think the energy problem is a serious one.

Results indicated that young adults felt energy shortages do pose a serious threat to the future well-being of most American. Most realize that the United States is not the only country in the world with energy problems. Respondents felt that energy problems are not past, that all energy problems will not be solved in the next ten years, and that there will be more gasoline shortages in the United States.

Energy considerations do appear to influence young adults when they purchase cars and appliances, travel to work, heat their homes, and vote. A high percentage of the respondents believe

that as world consumption of energy increases there will be less energy available in the United States and that there will probably be wars over energy supplies.

When asked if America should develop energy independence even if this means energy will cost more, 36 percent strongly agreed and 42 percent moderately agreed. Only 14 percent moderately disagreed and 6 percent strongly disagreed. From these responses, National Assessment staff inferred that most young adults think the energy problem is a serious one.

Nine questions were designed to study attitudes about the extent to which people think their personal actions and behaviors have implications for others. Corollary issues were whether or not people want more information about the problem and what choices individuals will make in terms of their own actions.

The majority of respondents tended to think that citizens can influence the government, manufacturing, and oil companies. However, one-third doubted that citizens can influence such agents. The majority of respondents wanted more information about energy problems and about energy conservation.

When asked about their personal choices of means of traveling one-half a mile, more than half of the respondents selected "using a car." Slightly more than one-third chose either walking, riding a bike or riding a bus.

Viewed as a whole, responses to the questions in this group suggest that young adults are aware of their potential to influence major decisions about the energy problem, are concerned about the energy problem to the extent that they desire more information on the subject, and are perhaps moving in the direction of incorporating choices in their personal actions that may help ease the energy problems.

Attitudes of adults toward environmental hazards were studied in terms of whether or not people feel that declining environmental quality is a serious threat and whether they would tolerate certain energy sources near their homes. They were also asked if they agreed or disagreed that declining environmental quality poses a serious threat to the future well-being of most Americans. Nearly 90 percent agreed that this is the case.

They were also asked how serious they considered several potential hazards associated with nuclear power (disposal of radioactive waste, explosion, theft of plutonium, radiation exposure from normal operation, thermal pollution). Each hazard was to be categorized as very serious, moderately serious, or not serious. Each was considered more serious than not, with the disposal of radioactive waste regarded as the most serious hazard listed.

When asked to identify which of eight types of energy producers they would be

willing to have built within 25 mile of their homes, young adults marked only large windmills and large solar energy collectors as acceptable. Nuclear power plants received more "no" responses than any of the other seven (large windmills, large solar energy collectors, dam with hydroelectric plant, geothermal power plant, coal-burning power plant, coal gasification plant, oil shale processing plant).

A series of questions was designed to ascertain whether young adults had an environmental perspective or an energy development perspective. Responses suggested a fairly strong preference for environmental concern as opposed to at-all-costs energy development. However, a substantial number (37 percent) disagreed that auto pollution control is more important than gasoline mileage. The majority disagreed that we should use all of the natural gas, oil and gasoline we need now.

Certain energy solutions have implications beyond the present. The quest for energy alternatives forces the consideration of the trade-off between generating more energy and possible high risks to health, safety, the environment, and the social and economic well-being of the nation.

Young adults were asked to evaluate the seriousness of problems associated with seven energy-producing sources (coal mining, nuclear-powered generators, offshore drilling and the Alaskan oil pipeline, importing or shipping foreign oil to the U.S., coal-powered generators, oil shale) across three major trade-off areas: health and safety, the environment, and social and economic impact.

In terms of health and safety, coal mining was thought to offer the most serious energy trade-off and oil shale, the least serious. In terms of environmental problems, nuclear-powered generators were viewed as presenting the most serious energy trade-off, with coal mining a close second. Solar heat collectors were considered the least serious threat to the environment. In terms of social and economic impact, there was yet a third ranking. The importation of foreign oil was viewed as being the most serious. These results suggest that young adults have a different perspective on the various energy producers, depending on whether they are viewed in terms of health and safety, the environment and pollution, or social and economic impact. The ratings also suggest that young adults may not have sufficient information about the relative seriousness of the energy producers.

What do the Results Mean?

The National Assessment staff does not make interpretative comments about the data it collects. However, comments from outside experts in the field are invited. The report concludes with a chapter containing reactions from four persons interested in and knowledgeable

about energy education who served as consultants to the National Assessment staff.

These consultants saw both positive and negative implications. There was evidence of deeper awareness and concern about the energy situation than was indicated by earlier polls (by other groups). However, the sample did not really have the understanding of deeper issues and concepts that is necessary for making informed decisions. Present results seem to indicate a high exposure to information about energy problems and issues. Probably much of this information comes from the popular press rather than from schools.

While young adults demonstrated quite a bit of concern and awareness, they did not demonstrate commensurate knowledge or deep understanding of the kind of choices an informed citizenry must make. There was little evidence of understanding of trade-offs, time lags in energy production, conversion processes, and the technologies associated with energy development.

The prevailing lifestyle of the last 10-20 years has raised the expectations of young adults. They expect to be able to continue to depend on high energy use. Results of the survey suggest that the last area in which young adults are willing to conserve is in personal transportation.

There are contradictions in perceptions about the seriousness of the problem. Young Americans are pessimistic in their attitudes toward the seriousness of the energy problem but they are naively optimistic about potential solutions. Their attitude may be translated as "through technology, scientists will solve everything." (p. 28) Apparently the less young adults know about energy technology, the more optimistic they tend to be about it.

Young adults showed little evidence of making distinctions among alternative energy sources, particularly those sources requiring knowledge of science and engineering. They do not appear to understand that most of our electricity comes from coal. Young adults seem to know most about transportation and their cars and next most about petroleum, its by-products and uses.

Young adults show little evidence of being prepared to select practical energy options for the future. There is no evidence that supports the idea that this age group has thought realistically about various energy technologies and conversions and the many problems associated with energy alternatives.

The consultants raised the question of how important is it that people understand some of the details associated with the energy problem and the selection of alternative energy sources? There appears to be a need for "how to" information that can be quickly and widely disseminated throughout the country for the benefit of all age popula-

tions. There is also a need for an infusion of energy facts and information into existing curricula in the schools. Energy information can be used to enrich the curriculum rather than replacing some of the current curriculum material, in both social studies and science courses.

Ninety-five percent of the young adults sampled believe that such topics as basic energy knowledge, energy problems, the future of energy, etc. should definitely be an important part of every school's curriculum. Full-scale educational implementation of energy information in schools appears to be a somewhat distant goal. While there are some exemplary materials on energy available for grades K-12, there appears to be little widespread communication and cooperation within or between states to further energy education. Few state legislatures and/or governors' offices have provided input, financial or otherwise, into the K-12 energy education effort, with most states' K-12 energy education programs being funded by the federal government.

Additional NAEP Data: Science and Society Concerns

The most recent assessment of science achievement took place during the 1976-77 school year. In addition to seeking information about students' knowledge of science content and of science processes, items were designed to provide information about students' knowledge in the area of science and society: the implications of science for mankind. The science and society items emphasized persistent societal problems, science and self, and applied science.

These three components were considered to reflect the general goal of science education that students should understand the implications of science for their own lives and the lives of other people. The questions about *persistent societal problems* were designed to assess students' understanding of society's technological development. Four topics were included: health and safety, environment, growth, and resource management. Within the *science and self* area were questions about the everyday use of science by the individual and personally relevant topics such as health, nutrition, and safety. *Applied science and technology* topics dealt with the application of knowledge in biological, physical and earth sciences to a variety of societal issues and with an understanding of the potential payoffs and/or dangers of various scientific and technological endeavors.

The following findings relate to areas of science and society. Seventy-seven percent of the *nine-year-olds* who were tested could apply their knowledge of ecosystems to an understanding of why populations will stop increasing in size

when there is a limited amount of food, space and air. Only 46 percent could apply their knowledge of nutrition to select a balanced menu over menus that emphasize mainly carbohydrates and fats, protein, or carbohydrates alone.

Sixty percent of the 13-year-olds understood that venereal disease is common today among people in all kinds of communities, not only among poor people, criminals, city people, young people or people over 25. Thirty-six percent understood that harvesting, not yield, growth, or use of fertilizers, is the major problem of planting high-yield grains in underdeveloped countries. Twenty-nine percent knew that cars, not open trash burners, fog or factories are the major cause of air pollution in most large American cities. Twenty percent understood that "no smoking" signs are meant to control the supply of burnable material that could start a fire, that foam fire extinguishers are meant to control the supply of oxygen available for a fire and that heavy electrical wires and brick walls are meant to control high temperatures of a fire.

Ninety-three percent of the 17-year-olds answered the question about venereal disease correctly. Eighty-two percent could apply planning theory to select the most accurate definition of a problem that has conflicting environmental and economic benefits. Seventy-one percent understood the concept of energy transformation as it applies to four examples of possible change. Only thirty-seven percent knew that cars, not open trash burners, fog or factories are the major cause of air pollution in most large American cities. Twelve percent knew that a wide variety of consumer products such as plastics, synthetic fabrics, etc. are petroleum products.

When performance of males and females was analyzed, females outperformed males in the areas of decision-making and science-and-self. The performance of males was higher than that of females for persistent societal problems (except for the nine-year-old group) and for the area of applied science and technology (for which nine-year-olds were not sampled). Black students as well as white students living in advantaged-urban communities performed significantly higher than did their peers living in disadvantaged-urban communities. Blacks, poor whites, Hispanic students, and females tended to perform consistently below national averages at the three age levels tested.

In his commentary on these results, Lester G. Paldy, Dean of Continuing and Developing Education at the State University of New York at Stony Brook, wrote:

To remedy the inequalities in science achievement documented in the National Assessment report, and to prepare disadvantaged and in-

adequately represented members of society to assume positions requiring technical and scientific competence, requires a comprehensive plan of action that links all elements of American society. The 9-year-olds discussed in the NAEP report will become our leaders in the first half of the 21st century. If their ranks are to include adequate representations of minority members and women, we must begin as soon as possible. We now command the resources and possess the technological capacity to educate people in their homes and to share information at a rate and scale that staggers the intellect. If our children are to be ready for the 21st century, we must begin to prepare them now. (p. 39)

ENERGY CONSUMPTION IN THE NATION'S SCHOOLS

In 1979 a survey was made of a systematic random sample of the nation's schools to determine their energy consumption. Schools involved were drawn from the membership list of the American Association of School Administrators (AASA) and were stratified by district size. Using a ratio of 1:4 for districts over 25,000 enrollment and 1:7 for districts under that figure, a sample of 2127 schools was drawn. This sample was matched to the universe of school systems and to the number of districts in the ten federal energy regions and found to be generally representative.

Because the federal energy regions will be discussed relative to the study's findings, it seems appropriate to identify the states included in the ten regions. These regions are, for the continental United States,

- 1 Maine, Massachusetts, Vermont, Connecticut, New Hampshire
- 2 New York
- 3 Pennsylvania, West Virginia, Virginia, Maryland
- 4 Kentucky, Tennessee, North Carolina, South Carolina, Mississippi, Alabama, Georgia, Florida
- 5 Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota
- 6 Arkansas, Louisiana, Oklahoma, Texas, New Mexico
- 7 Iowa, Nebraska, Kansas, Missouri
- 8 North Dakota, South Dakota, Montana, Wyoming, Utah, Colorado
- 9 Nevada, Arizona, California, Hawaii
- 10 Washington, Oregon, Idaho, Alaska

Region 2 also includes Puerto Rico and the Virgin Islands. Region 4 includes the Canal Zone, and Region 9 includes American Samoa, Guam, and the Trust

Territory for the Pacific Islands.

A survey instrument was developed in consultation with the Department of Energy and mailed to the schools. A usable response rate of 29.57 percent was identified when the returns were analyzed. This approximately 30 percent rate is statistically sufficient for the conditions of the study but it also means that caution should be used in interpreting the data. In some instances the rate of response was too low to treat the data at all. Analysis of the usable responses indicated that region 5 was overrepresented and districts under 300 in size were underrepresented.

Data were not adjusted for climate. Readers need to recall that 1977-78 was one of the two worst years, for cold weather, in the last half-century, according to the weather bureau. The effects of school closings due to fuel curtailment in the winter of 1977-78 were considered but, since the total number of pupil days lost was less than one percent of the operational demand, this factor was disregarded.

Individuals analyzing the study's data considered the median BTU's per square foot by total and by Federal Energy Administration's earlier findings. (BTU stands for British thermal unit, a unit of heat equal to 252 calories or the quantity of heat required to raise the temperature of one pound of water from 62°F to 63°F.) Consumption figures by region logically followed the respective severity of the climate, with a decrease in consumption for all regions as compared with the earlier data, even when the climatic demands on energy were great.

Questions in the survey were not designed to determine how these energy reductions were accomplished nor the amount of money invested in energy conserving measures. The analysis inferred that savings could be primarily attributed to changes in operations, more energy conscious maintenance, and implementation of low cost retrofits.

The study also found that districts with over 5,000 pupils consumed 11.6 percent less fuel than those districts under 5,000 in size. This finding may suggest the benefits of on-staff expertise in energy conservation. If this is a valid assumption, the use of educational service agency resources to assist smaller school districts might be a very cost-effective vehicle for training and technical assistance.

An analysis was made of the types of fuel used by the schools, nationally and by regions. No prior figures are available for comparison purposes. Natural gas consumption on a national basis was 55 percent. The second most widely used type of fuel was oil (all grades) at 25 percent. Other types of fuels were electricity for heating and cooling, 7.4 percent and for heating only, 8.8 percent; propane, 2 percent; coal, 1.5 percent; butane, .002 percent; and diesel fuel, .0015 percent.

Variations in fuel source by region

were far greater than expected and pointed up differences of considerable importance to decisions relative to energy in the schools. For instance, oil provided 31 percent of the fuel used in region 3 but only .3 percent for region 6. This is significant when reduction in oil imports is considered. Any analysis of the economic impact of gas deregulation on the schools should consider that the impact would be much greater in regions 4 (18 percent of the fuel used), 5 (20 percent), 6 (23 percent), and 9 (17 percent) than in regions 1 (.6 percent of the fuel used), 2 (1 percent), and 10 (2 percent). Coal strikes would have the most impact on regions 3 (31 percent of the fuel used), 4 (21 percent) and 5 (31 percent).

An analysis of the fuel sources region by region showed that, in region 1, oil supplies 79 percent of the schools' energy while 11 percent comes from gas and 9 percent from electricity. However, region 6 gets 79 percent of its fuel from natural gas for school needs. The use of oil is negligible and electricity makes up 18 percent of the energy used.

District size appears to influence some fuel usage. Larger districts use a disproportionate amount of natural gas. Small districts show greater reliance on electricity. Oil appears to supply about 25

percent of the districts, regardless of size.

The analysts for the American Association of School Administrators conclude that, while the 35 percent reduction in consumption of fuel over a five-year period is quite remarkable, the average 1977-78 consumption figure of 104,445 BTU's per square foot leaves room for future conservation efforts. Reductions suggest that schools are ready to take advantage of federal assistance in the school energy grants program. Savings already evident indicate that sources of self-help are being exhausted and that assistance with capital investments to save energy should bring maximum benefits.

Difference in consumption of various fuels by region warrants careful scrutiny, the analysts write. They suggest that in certain regions where fuel consumption profiles are distinctive, technical assistance and specific conservation efforts should be adapted accordingly.

The magnitude of consumption differences by district size should be studied further. These differences are sufficient to recommend that more attention needs to be paid to assisting smaller school districts in their efforts to conserve energy. Educational service agencies are natural vehicles for offering this assistance and methods of utilizing their services should be explored.

This report, despite the small percentage of usable returns, deserves the attention of both school administrators and energy experts. Administrators need to consider the educational program their schools offer in relation to the type of fuel they use. If conversion measures appear too expensive relative to school finances available, they need to take advantage of the school energy grants program.

Experts predict the supply of the world's oil will be in a short-fall situation by the year 2000. Before this date is reached in 20 years, strong oil conservation measures are going to be needed. Costs may double or triple as the oil supply is depleted or oil embargos are imposed. Region 3, with its present 31 percent rate of oil consumption for school fuel, should be especially conscious of this situation. Region 3 also uses coal for another 31 percent of its fuel. As oil prices increase, schools in Pennsylvania, West Virginia, Virginia and Maryland would have severe problems if coal miners were to go on a prolonged strike.

School administrators need to work with educational service agencies and other sources of assistance related to energy conservation to establish policies for future decisions regarding the building of new schools and the implementation of procedures to make existing schools more energy efficient.

PERCENTAGE OF CONSUMPTION, BY REGION, OF SPECIFIED FUELS (BY SCHOOL BUILDING COUNT)*

FUEL SOURCE

Fed. En. Region	Natural Gas		Oil		Htg/c %	Electrical			Co/only		Coal		Propane	
	%	n	%	n		Htg/only %	n		%	n	%	n	%	n
1	.6	34	8.6	236	2	13	2	16	1	9	0		2	4
2	1	81	10.7	293	1	9	4	37	1	13	0		.4	1
3	4	255	31	854	12	97	6	58	15	125	31	53	.4	1
4	18	1072	9	248	22	182	23	220	24	205	21	36	45	99
5	20	1215	16	447	13	106	15	149	12	101	31	53	4	9
6	23	1370	3	9	25	206	11	104	20	168	0		11	25
7	8	456	6	164	6	51	5	45	4	33	3	6	19	42
8	6	348	2	54	5	44	21	204	2	14	6	11	10	22
9	17	1044	1.6	45	7	54	7	73	19	165	0	—	6	13
10	2	124	14	387	6	47	6	56	2	19	5	9	2	4
Total		5999		2734		809		962		852		168		220

Note: the document from which this report was made in being placed in the ERIC system. Its SE number is 029 342. It is entitled *AASA Energy Use Study* and is dated August, 1979. Individuals wishing further information are asked to contact Dr. Shirley J. Hansen, Director of Energy Programs, AASA, 1801 North Moore Street, Arlington, VA 22209.

ERIC — SMEAC Publications in Environmental Education

Energy Activities for the Classroom.
Herbert Coon and Michelle Alexander,
editors. \$4.95 ED 130 833

This sourcebook, designed for use in grades K-12, contains energy teaching activities related to energy resources, production, distribution, and use. Each activity has been classified by the editors according to the most appropriate grade level, subject matter, and energy concept involved. Subject areas are science, mathematics, social studies, language arts, and fine arts. References cited in specific activities could be useful to persons interested in obtaining more activities and ideas related to energy. Many activities are interdisciplinary in nature and were developed or suggested by public school teachers.

Recycling: Activities for the Classroom.
Mary Lynne Bowman and Herbert L. Coon, editors. \$4.95 ED 159 075

This publication contains activities designed to help teachers involve stu-

dents in examining the nature and importance of recycling. For each activity a purpose, grade level, subject matter area, and recycling concept are given. Social studies (52 activities) and science activities (45) predominate but other teaching areas are also represented. Many activities are interdisciplinary. A section listing readings, films, and organizations to contact for recycling information is included.

Energy Education: A Bibliography of Abstracts from Resources in Education (RIE) from 1966-1978. Milton Rinehart et al., compilers.
\$5.50 ED 166 067

This compilation of abstracts from *Resources in Education* (RIE) identifies publications relating to energy education: (1) instructional materials such as teaching activity guides, (2) teacher resource guides, (3) information sources on energy resources, or (4) school building conservation materials. Over 500 publications are identified. Subject, author, and institutional author indices are included to aid the user in locating a specific publication.

Energy Education: A Bibliography of Citations from Current Index to Journals in Education (CIJE) from 1966-1978. Milton Rinehart et al., compilers. \$5.50 SE 026 992

This compilation of annotations from *Current Index to Journals in Education* (CIJE) identifies articles relating to energy education: (1) instructional materials such as teaching activities, (2) teacher resources, (3) information sources on energy resources, or (4) school building conservation materials. Over 500 articles are included. Subject

and author indices are included to aid the user in locating a specific article.

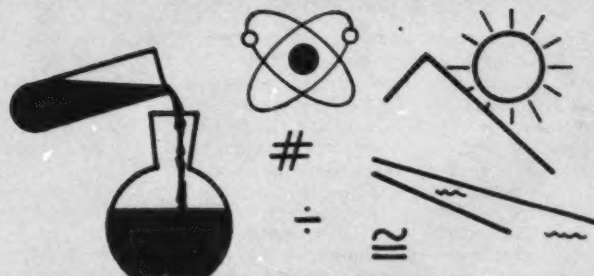
Energy Activities for the Classroom, Volume II. Herbert L. Coon and Mary Lynne Bowman, editors.
\$3.00 SE 027 730

This volume supplements, but does not replace, the previously-described sourcebook edited by Coon and Alexander (ED 130 833). It is also designed for use in grades K-12 and contains energy teaching activities related to energy resources, production, distribution and use. Each activity has been classified according to most appropriate grade level, subject matter, and energy concept involved. Subject areas are science, mathematics, social studies, language arts, and fine arts. References cited in specific activities may be useful to persons interested in obtaining more activities and ideas related to energy. Many of the activities are interdisciplinary in nature and were suggested or developed by public school teachers.

Readers wishing to order a copy of any of these publications may either contact the ERIC Clearinghouse for Science, Mathematics and Environmental Education and order directly from the Clearinghouse or may purchase the publications from the ERIC Document Reproduction Service (EDRS), P.O. Box 190, Arlington, VA 22210. Materials ordered from EDRS may be purchased as microfiche or papercopy. Prices for microfiche or papercopy are quoted in the document resumes in *Resources in Education* (RIE). Clearinghouse documents with SE numbers have been sent to EDRS for inclusion in a future issue of *Resources in Education* (RIE). When each document is announced in RIE, it will have an ED number in addition to its SE number.



Clearinghouse for Science, Mathematics and Environmental Education



SOME TOPICS OF CURRENT INTEREST TO TEACHERS OF SCIENCE, MATHEMATICS, OR ENVIRONMENTAL EDUCATION

This issue of the ERIC-SMEAC information bulletin contains information, published in *Resources in Education* (RIE) in 1979, which is related to some questions frequently asked of ERIC-SMEAC staff members. These questions reflect topics of current interest to teachers and administrators. Some areas of concern to science teachers are science and the handicapped, safety, and careers for women in science. Mathematics topics focus on calculators, math anxiety, and mathematics assessment. Environmental education topics are related to both energy education and environmental education.

Staff members have identified some relevant ED (educational document) entries dealing with the topics listed above. The document entries have been taken directly from issues of *Resources in Education*. These entries are not intended to be exhaustive but are representative of the documents recently added to the ERIC system.

The documents may be purchased from the ERIC Document Reproduction Service (EDRS), P.O. Box 190, Arlington, VA 22210. A few documents contain the notation "HC (or PC) not available from EDRS." This means that papercopy is not available from EDRS although microfiche copies of the document may be purchased. Complete ordering information is found in the back pages of each issue of *Resources in Education*.

If the document of interest is a product of the ERIC Clearinghouse for Science, Mathematics or Environmental Education, it may be purchased directly from the Clearinghouse or ordered from EDRS.

SCIENCE AND THE HANDICAPPED

ED 161 714 SE 025 177

Hofman, Helenmarie, Ed.

A Working Conference on Science Education for Handicapped Students: Proceedings (April 3-5, 1978).

National Science Teachers Association, Washington, D.C.

Spons Agency—National Science Foundation, Washington, D.C.

Pub Date—78

Note—392p.: Not available in hard copy due to numerous small and light type throughout entire document

EDRS Price MF-\$0.83 Plus Postage. HC Not Available from EDRS.

Descriptors—Blind Children. *Conference Reports, Crippled Children, Curriculum, Deaf Children. *Elementary Secondary Education, Facilities. *Handicapped, Handicapped Children. *Handicapped Students, Instruction, Instructional Materials, *Physically Handicapped. *Science Education

This conference attempted to assess the state of the art and develop recommendations for new directions in science education and careers in science for the handicapped student. Panel discussions were held on such topics as: (1) attitudinal barriers and other obstacles to handicapped students; (2) current practices relating to all physical handicaps; (3) mainstreaming and the law; (4) current practices related to auditorially handicapped students; (5) visually handicapped students; (6) science education, the handicapped, and careers; (7) orthopedically handicapped students; and (8) science careers for handicapped students. Through working sessions the conference participants developed a position statement of science education for the physically handicapped student. Recommendations for action are addressed to various groups. (Author/BB)

ED 186 378 CE 018 924

A Science-Oriented Career Guidance System for the Physically Handicapped. Final Report & External Evaluation.

Thomasville Board of Education, Ga.

Spons Agency—National Science Foundation, Washington, D.C.

Pub Date—31 Oct 78

Note—73p.

Pub Type—Reports - Descriptive (141)

EDRS Price MF-\$0.83 HC-\$3.50 Plus Postage

Descriptors—Adults, Audiovisual Aids, Aurally Handicapped, *Career Awareness, Career Opportunities, *Career Planning, Guidance Objectives, Guidance Programs, Handicapped Students, Independent Study, Information Dissemination, *Information Systems, Mass Media, *Occupational Guidance, Occupational Information, Orthopedically Handicapped, *Physically Handicapped, Secondary School Students, Systems Development, Visually Handicapped

A career guidance system to encourage and assist physically handicapped secondary level students and adults to undertake science careers was designed, produced, and field tested. Focus is on visual, hearing, and orthopedic handicaps. The following products were developed: (1) two hundred twenty-eight science-related career briefs in large print, audio tape, Braille, and microfiche formats (each includes job description, preparation requirements, earnings, and employment outlook); (2) ten sound filmstrips showing sixty handicapped scientists filmed on the job; (3) radio and television public service announcements about science career opportunities for the physically handicapped; (4) a science career guide for the visually handicapped; (5) self-career exploration and decision making exercises; and (6) companion science and work-related glossaries for those

with severe hearing handicaps. These products can be used independently by handicapped and non-handicapped individuals in classrooms, rehabilitation centers, and other career guidance settings as well as for the training of personnel for these locations. A project evaluation indicated that all developmental objectives were met. The major problem was the lack of time for adequate field testing of developed materials. (The appendix, comprising two-thirds of this report, includes the following: a list of the two hundred twenty-eight career brief jobs, sample career briefs, sample scripts for television and radio public service announcements, sample letters, and sample interview and survey forms.) (EM)

ED 171 071 EC 115 280

Cardullias, Peter J. And Others

Three Adapted Science Skill Builders for Junior and Senior High School Orthopedically Handicapped Students.

Pub Date—Apr 79

Note—21 p.; Paper presented at the Annual International Convention, The Council for Exceptional Children (57th, Dallas, Texas, April 22-27, 1979. Session W-86)

Pub Type—Reports - Research (143) — Speeches/Meeting Papers (150)

EDRS Price - MF01/PC01 Plus Postage.

Descriptors—*Exceptional Child Research, Instructional Materials, *Material Development, *Physically Handicapped, *Science Equipment, *Science Experiments, Science Instruction, Secondary Education

The study was designed to determine how standard science skill builder activities can be modified or adapted for use by orthopedically handicapped students. Nine secondary level science experiments were selected for initial review and from these, three were selected for adaptation — use of the microscope, use of graduated cylinders, and use of the balance.

Each of the activities was modified in terms of three levels of involvement of orthopedically handicapped: mildly involved—defined as ambulatory with or without assistance, use of one or both hands, can be an active participant in the experiment; moderately involved—confined to a wheelchair, use of one or both hands, may have muscular dysfunction, may have a moderate degree of participation and may need some assistance in the experiment; and severely involved—confined to a wheelchair, minimal use of hands and a high probability of being a passive participant in the experiment. As each skill builder activity was conducted as it would be in an average secondary school, task analyses were conducted to identify possible problems that might occur when the activities are being performed by orthopedically handicapped learners. (The revisions of the adapted skill builder activities appear in their final form in the last section of the document with sections on use of each instrument, pre-skills needed, expected outcome, experimental steps, adaptations needed for each level of involvement, major equipment modification, and demonstration of learning.) (SBH)

ED 171 531 SE 027 592

McCarley, Orin, Ed.

Science Education News, Fall 1978/Winter 1979.

American Association for the Advancement of Science, Washington, D.C.

Report No.—AAAS-Pub-79-N-1

Pu Date—79

Note—13p.

Available from — Science Education News, American Association for the Advancement of Science, 1515 Massachusetts Avenue, N.W., Washington, D.C. 20005 (no price quoted)

Pub Type—Collected Works - Serials (022)

EDRS Price - MF01/PC01 Plus Postage.

Descriptors—*Aurally Handicapped, Blind, Career Opportunities, Counseling, Deaf Education, Elementary Secondary Education, Higher Education, Mainstreaming, *Physically Handicapped, *Science Education, *Visually Handicapped

This issue of the American Association for the Advancement of Science (AAAS) newsletter is devoted to the science education for physically, visually, and aurally handicapped children. Articles include thoughts on teaching deaf students and blind students, a brief description of a science program for young physically handicapped children, aids in teaching laboratory science to visually impaired students and deaf students, aids in teaching field aspects of science to the physically handicapped, and counseling of the handicapped for a career in science. A collection of addresses of organizations and sources of information for teachers who have handicapped students in their classes is included. (MA)

ED 173 126 SE 027 959

Adams, Gary H., Comp.

Science for the Physically Handicapped in Higher Education: A Guide to Sources of Information.

National Oceanic and Atmospheric Administration (DOC), Washington, D.C. Environmental Data Service.

Pub Date—Apr 79

Note—39p.

Pub Type—Reference Materials Directories/Catalogs (132)

EDRS Price - MF01/PC02 Plus Postage.

Descriptors—*Access to Education, Ancillary Services, *Career Opportunities, Educational Opportunities, Equipment, Federal Programs, Higher Education, *Information Needs, Information Utilization, *Physically Handicapped, Reference Materials, Rehabilitation, *Science Education Identifiers—*National Oceanic and Atmospheric Administration

This guide is intended to be a reference for persons needing to know where to find information about science education, career opportunities, and other programs for physically handicapped individuals. Sources listed in the guide include: (1) Federal agencies that run assistance programs for the handicapped; (2) Professional societies specifically interested in promoting opportunities in science for the handicapped; (3) Organizations and companies that provide assistance in making laboratories or buildings accessible and manufacture special equipment for handicapped persons; (4) Libraries and information centers which have science education collections or act as clearinghouses for science career, education, financial, and equipment information; (5) Printed sources, such as directories, handbooks, and guides which provide information about handicapped scientists, recruitment and admissions of handicapped students, funding sources, and accessible universities and their programs; and (6) Computerized information systems which provide on-line access via teletypewriter terminals to databases which contain information on science education, research, and teaching materials for handicapped students. The guide should be of interest to educators, administrators, and researchers in all areas of secondary education, rehabilitation, universities, businesses and government. (Author/SA)

SAFETY

ED 164 250 SE 025 000

Dean, Robert A. And Others

Safety in the Secondary Science Classroom. National Science Teachers Association, Washington, D.C.

Pub Date—78

Note—108p.; Not available in hard copy due to copyright restrictions

Available from—National Science Teachers Association, 1742 Connecticut Avenue, N.W., Washington, D.C. 20009 (Stock Number 471-14752; \$4.00)

EDRS Price MF-\$0.83 Plus Postage. HC Not Available from EDRS.

Descriptors—*Accident Prevention, Biology, Chemistry, *First Aid, *Health, Injuries, *Laboratory Safety, Physics, *Safety Education, School Safety, Science Education, Secondary Education

This booklet is made available by the National Science Teachers Association to provide district safety officers, school principals, science department heads, and secondary school science teachers with information on safety in schools, especially in science classrooms. The range of information includes Occupational Safety and Health Administration, first aid, general and specific instructions to teachers and students in biology, physics, chemistry, and life/physical science classes, and safe practices to follow for extra curricular activities. The publication is a compilation of recommended practices in the area of science taken from many sources throughout academia and industry. The booklet includes a recommended standard student accident report format and a bibliography for further reference. (GA)

ED 174 472 SE 028 544

Crowder, Betty Pogue And Others

Oakland County Science Safety Series: Reference Guide for Elementary Science.

Oakland County Schools, Pontiac, Mich.

Pub Date—77

Note—102p.; For related documents, see SE 028 545-547; Not available in hard copy due to copyright restrictions; Contains colored pages that may not reproduce well; Pages 63-64 removed due to copyright restrictions; Guide prepared by the Division of Instruction

Available from—Oakland Schools, Division of Instruction, 2100 Pontac Lake Road, Pontiac, Michigan 48054 (\$8.50 complete set; \$2.50 ea.)

Pub Type—Guides - Classroom - Teacher (052)

EDRS Price - MF01 Plus Postage. PC Not Available from EDRS.

Descriptors—*Accident Prevention, *Class Activities, *Elementary Education, *Elementary School Science, Field Trips, Laboratory Procedures, Laboratory Safety, Safety, *School Safety, *Science Education, Science Instruction

This reference guide is designed to organize and suggest acceptable practices and procedures for dealing with safety in elementary science instruction. It is intended as a reference for teachers, administrators, and other school staff in planning for science activities and in making daily safety decisions. Topics covered in the guide include: (1) responsibility; (2) animals; (3) chemicals; (4) electricity; (5) field trips; (6) first aid; (7) high risk labs; (8) lab equipment; (9) open flames; (10) plants; (11) model rockets, etc.; and (12) safety glasses. Several appendices deal with specialized considerations. (Author/RE)

ED 174 473 SE 028 545

Bury, Dan And Others

Oakland County Science Safety Series: Reference Guide for Biology.

Oakland County Schools, Pontiac, Mich.

Pub Date—77

Note—122p.; For related documents, see SE 028 544-547; Not available in hard copy due to copyright restrictions; Contains occasional colored pages which may not reproduce well; Guide prepared by the Division of Instruction

Available from—Oakland Schools, Division of Instruction, 2100 Pontiac Lake Road, Pontiac, Michigan 48054 (\$8.50 complete set; \$2.50 ea.)

Pub Type—Guides - Classroom - Teacher (052)

EDRS Price - MF01 Plus Postage. PC Not Available from EDRS.

Descriptors—*Accident Prevention, *Biology, Laboratory Procedures, Laboratory Safety, *Safety, Safety Equipment, *School Safety, *Science Education, *Science Instruction, Secondary Education

This reference guide is designed to organize and suggest acceptable practices and procedures for dealing with safety in the area of biology instruction. It is intended as a reference for teachers, administrators, and other school staff in planning for science activities and in making daily safety decisions. Discussions deal with responsibility for safety, microbes, use of plant materials, use of animals, laboratory activities with humans, safety glasses, use of laboratory equipment and supplies, field trips, high risk experiments, special activities, emergencies, and recommendations. Numerous appendices deal with specialized considerations. (RE)

WOMEN IN SCIENCE

ED 164 290 SE 025 436

Weiss, Iris R. And Others

The Visiting Women Scientists Pilot Program 1978: Highlights Report

Research Triangle Inst., Durham, N.C. Center for Educational Research and Evaluation. Spons Agency—National Science Foundation, Washington, D.C.

Report No.—RTI-1481-00-02-F

Pub Date—Aug 78

Contract—SPI-77-21-262

Note—17p.; For related document, see SE 025 437

EDRS Price MF-\$0.83 HC-\$1.67 Plus Postage.

Descriptors—*Career Education, *Females, *Feminism, *Higher Education, *Science Careers, *Science Education, *Scientists, *Womens Education, *Working Women

This publication describes a pilot program which involved 40 women scientists and consisted of visits to 110 high schools in the United States. Each visit involved some of the following activities: (1) a large group meeting of tenth-grade female students; (2) seminars for approximately 30 female students; (3) meetings with individual classes; (4) meetings with school personnel; (5) informal chats with students; and (6) an informal meeting with the school principal or contact person. This document presents an overview of the program, and describes the selection of the high schools to be visited, the selection of the women scientists, the conduction of the meeting, and the evaluation of the program. (BB)

ED 167 422 SE 026 847

Smith, Walter S. Stroup, Kala M.

Science Career Exploration for Women

National Science Teachers Association, Washington, D.C.

Pub Date—78

Note—80p.; Not available in hard copy due to copyright restrictions

Available from—National Science Teachers Association, 1742 Connecticut Avenue, N.W., Washington, D.C. 20009 (Stock Number 471-14748; \$2.50)

Pub Type—Guides - Non-Classroom (055)

EDRS Price MF-\$0.83 Plus Postage. HC Not Available from EDRS.

Descriptors—Career Education, *Career Exploration, *Females, *Feminism, *Role Models, *Science Careers, *Science Education, *Scientific Personnel, *Scientists, *Women Professors, *Womens Education, *Women Teachers, *Working Women

The main body of this pamphlet presents science career exploration activities for women in the form of six modules. Complete modules can be used as presented or activities may be adapted or borrowed to suit individual situations. The modules are titled: (1) Turning A Girl Onto Science Careers; (2) What Do I Want Out of Life?; (3) How Do Parents and Friends Affect a Woman's Career Choice?; (4) What Careers Are Available?; (5) What's It Like to be a Professional Women in a Science Career?; and (6) OK, I'm Sold on Trying a Science Career, But How Do I Get From Here to There? In addition, some information on how to use the modules is presented along with a discussion of sources of conflict in females at adolescence. (BB)

ED 167 425 SE 026 869

Davis, Audrey B.

Bibliography on Women: With Special Emphasis on Their Roles in Science and Society.

Pub Date—74

Note—55p.

Available from—Science History Publications, 156 Fifth Avenue, New York, New York 10010 (\$3.00)

Pub Type—Reference Materials - Bibliographies (131)

EDRS Price MF-\$0.83 HC-\$3.50 Plus Postage

Descriptors—Books, *Females, *Feminism, *Physiology, *Science Careers, *Scientists, *Womens Education, *Womens Studies

This bibliography comprises selected books and articles from "The Library of Congress Catalogue A Cumulative List of Works" for the years 1950 to March 1973, and unprinted cards for the preceding years. The purpose of the selection is to show the numerous possibilities for locating research materials on the roles and accomplishments of women and the attitudes toward them. The entries are listed alphabetically by author. In addition, other sources of articles about women are mentioned, and a list of publishers specializing in books related to studies of women is given. (BB)

ED 170 125 SE 027 557

Count Me In: Educating Women for Science and Math, Videotape Documentary and Brochure.

Mills Coll., Oakland, Calif.

Spons Agency—Office of Education (DHEW), Washington, D.C. Women's Educational Equity Act Program.

Pub Date—78

Note—26p.; Not available in hard copy due to copyright restrictions; Best copy available Available from—Education Development Center, 55 Chapel Street, Newtown, Massachusetts 02160 (no price quoted)

Pub Type—Reports - Descriptive (141)

EDRS Price - MF\$1 Plus Postage. PC Not Available from EDRS.

Descriptors—Career Choice, *Career Education, *Females, *Feminism, *Higher Education, *Mathematics, *Models, *Science Education, *Scientists, *Womens Education, *Womens Studies

Contained is a documentary of a comprehensive curricular/career model program at Mills College designed to help women enter scientific and technical fields. A series of vignettes illustrating key aspects of the program philosophy and methods is presented. Various viewpoints and experiences are related by women of different ages, ethnic backgrounds, levels of math preparation, and career aspirations in order to demonstrate that women can be motivated to enter non-traditional fields. Many elements of the program can be adapted for use at other educational levels and types of institutions to meet the needs of a variety of students. (Author/RE)

CALCULATORS

ED 159 480 CE 018 124

Carney, Richard

Your Electronic Hand Calculator. How to Get the Most Out of It.

Rutgers, The State Univ., New Brunswick, N.J. Curriculum Lab.

Spons Agency—New Jersey State Dept. of Education, Trenton, Div. of Vocational Education.

Pub Date—Sep 78

Note—232p.

Available from—New Jersey Vocational-Technical Curriculum Laboratory, Building 4103, Kilmer Campus, Rutgers University, New Brunswick, New Jersey 08993 (\$5.50 plus postage)

EDRS Price MF-\$0.83 HC-\$12.51 Plus Postage.

Descriptors—Calculation, Electronic Equipment, *Equipment Utilization, Manuals, *Mathematics Instruction, Postsecondary Education, Secondary Education Identifiers—*Calculators

Designed for use by students at beginning high school through adult levels, this manual contains seventeen lessons on uses of the electronic hand calculator. Within each of the eight sections lessons presented include objectives, procedural information, examples, and problems to be solved. Following an introductory lesson to the calculator, section 2 provides lessons on three fundamental operations: addition and subtraction, multiplication and division, and powers and roots. Section 3 lessons are on decimals and percents: rounding off numbers, fractions to decimals, and percentage. Two lessons on special features are given in section 4: multiplication and division by a constant, and memory. Section 5 covers order of operations; basic operations and parentheses. In section 6, special keys are presented: key, negative numbers and sign-change key, reciprocal key, and exchange keys. Section 7 has two lessons on the presentation of numbers: significant figures and scientific notation. Review problems are provided in section 8. Selected answers to problems presented in the various sections are appended, and an index is provided. (JH)

ED 161 757 SE 025 249
Getting to Know the Calculator, Problem Solving Project.

Northern Iowa Univ., Cedar Falls, Mathematics Learning Center.

Pub Date—75

Note—27p.; For related documents, see SE 025 250-251; Not available in hard copy due to marginal legibility of original document

Available from—The Director, Mathematics Learning Center, University of Northern Iowa, Cedar Falls, Iowa 50613 (no price quoted)

EDRS Price MF-\$0.83 Plus Postage. HC Not Available from EDRS.

Descriptors—*Calculation, Elementary Education, *Elementary School Mathematics, *Instruction, *Instructional Materials, *Learning Activities, *Mathematical Formulas, *Pattern Recognition, *Problem Sets, *Problem Solving

Identifiers—*Calculators, Estimation, Number Operations

Many problems and activities which can be worked with a calculator are contained in this booklet. The problems include: pattern recognition, combinations of operations, estimation, squares and square roots, rate problems, area, and volume. Chapter topics include: getting to know the calculator, single-step problems, using formulas, and multiple-step problems. (MP)

ED 161 758 SE 025 250
Calculator Handbook. Problem Solving Project.

Pub Date—75

Note—39p.; For related documents, see SE 025 249-251; Contains occasional light and broken type

EDRS Price MF-\$0.83 HC-\$2.06 Plus Postage.

Descriptors—*Calculation, Elementary Education, *Elementary School Mathematics, *Instruction, *Instructional Materials, *Learning Activities, *Pattern Recognition, *Problem Sets, *Problem Solving

Identifiers—*Calculators, Estimation, Number Operations

These student worksheets include ac-

tivities in counting, place value, estimation, the four operations with whole numbers, number patterns, volume, inequalities, decimal equivalents of fractions, and percents, all to be worked with a calculator. (MP)

ED 164 328 SE 025 940
Suydam, Marilyn N. And Others

Ohio Regional Conferences on Mathematics Education.

Ohio State Univ., Columbus. Center for Science and Mathematics Education.

Spons Agency—National Science Foundation, Washington, D.C.

Pub Date—78

Grant—NSF SER-77-20594

Note—291p.; Contains occasional light and broken type

EDRS Price MF-\$0.83 Plus Postage. HC Not Available from EDRS.

Descriptors—Calculation, Conference Reports, *Curriculum, Curriculum Development, Elementary Education, *Elementary School Mathematics, *Elementary School Supervisors, *Inservice Programs, Instructional Materials, Learning Activities, *Mathematics Education, *Problem Solving, Teacher Education

Identifiers—*Calculators, National Science Foundation

Five regional conferences designed for elementary supervisors and elementary mathematics educators were held in Ohio. The purposes of the conferences were: (1) to provide direction on the effective use of the calculator in the elementary school classroom; (2) to re-emphasize the importance of problem solving as a major curricular outcome; (3) to explore the interaction of the two areas and their relationship to the current emphasis on the basics; and (4) to establish links between supervisors and mathematics educators in each region for continuing curriculum development and improving instructional practice. Contents of this report include: (1) announcement and application forms; (2) sample schedules of the conferences; (3) conference evaluation forms and data from the evaluation; and (4) resource packets including papers presented or discussed at the conferences, sample materials, and transparency masters. (Author/MP)

MATH ANXIETY

ED 162 899 SE 025 428
Doyle, Mercedes Graesser, Arthur, II

Mathematical Problem Spaces of the Mathematically Anxious and the Mathematically Comfortable. Paper Presented at a Meeting of the Western Psychological Association, San Francisco, California, April 1978.

Spons Agency—California State Univ., Fullerton.

Pub Date—78

Note—23p.; Not available in hard copy due to marginal legibility of original document

EDRS Price MF-\$0.83 Plus Postage. HC Not Available from EDRS.

Descriptors—Algebra, *Anxiety, *College Mathematics, *Concept Formation, *Educational Research, Error Patterns, Higher Education, Mathematics Education, *Problem Solving, *Research

Identifiers—Research Reports

Verbal protocols were collected from math-anxious and math-comfortable college students while they solved algebra problems. These protocols were then examined for differences in problem-solving processes. Differences occurred in the use of two basic

strategies: generating values and symbolic transformations. The data suggest that for the math-anxious students the real problem is not numerical; rather, it is the inability to apply symbolic procedures. (MP)

ED 169 282 CE 020 390
Benton, Barbara L.

Math Avoidance and Pursuit of Fantasy Careers.

Pub Date—79

Note—37p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Francisco, California, April 8-12, 1979)

Pub Type—Reports - Research (143)—Speeches/Meeting Papers (150)

EDRS Price - MF01/PC02 Plus Postage.

Descriptors—Academic Aspiration, *Career Choice, *College Students, *Comparative Analysis, *Fantasy, Females, Males, *Mathematics, Questionnaires, Research, *Self Concept, Statistical Studies

Identifiers—*Mathematics Anxiety

Math avoidance has been hypothesized as related to career choice restrictions. Few attempts have been made, however, to assess the relative importance of the various components of math avoidance to career choice. Furthermore, it has been implied that persons fearful of math not only avoid specific careers but also reject careers that are otherwise seen as desirable. The purpose of this study was to examine the relative influence of several hypothesized correlates of math avoidance on academic major and career choice; and on fantasy career pursuit and rejection for men and women. One hundred twenty-nine undergraduate students responded to a personal data sheet and to two questionnaires: (1) The Mathematics Attitudes Scales (Fennema and Sherman, 1976); and (2) the Career Aspiration Scales, developed for this study. Five MAS scales discriminated groups by sex and major. Pursuers and rejectors differed by sex and major but not by attitudes toward math. Males and females differed on reasons for rejection of fantasy careers and on career discrepancies. (A bibliography is appended.) (Author/CT)

ED 171 550 SE 027 693
House, Peggy A.

Mathematics Anxiety and the Minnesota Talented Youth Mathematics Project.

Pub Date—79

Note—24p.; Paper presented at the annual meeting of the American Educational Research Association (San Francisco, California, April 8-12, 1979); Not available in hard copy due to marginal legibility of original document

Pub Type—Speeches Meetings Papers (150)—Reports - Research (143)

EDRS Price - MF01 Plus Postage. PC Not Available from EDRS.

Descriptors—Academic Achievement, Affective Behavior, *Educational Research, Gifted, Junior High School Students, Learning Motivation, Mathematics Education, *Research, *Secondary School Mathematics, *Sex Differences, *Student Attitudes, *Talented Students

This paper presented at the 1979 meeting of the American Educational Research Association (AERA), investigates the affective characteristics of 120 junior high school students who participated in one or both of the first two programs of Minnesota Talented Youth Mathematics Project (MTYMP). The first year program of 1976-77 was in algebra I and II, and the second year program of 1977-78 was

in geometry-trigonometry. Students were selected by their aptitude test scores in an annual talent search. No sex differences in achievement among these extremely talented youths have been found. However, the attrition by girls, especially after the first year, has been disproportionately high. Also, the attitudinal changes do exhibit sex differences. These results suggest that affective variables do affect the motivation and future plans of talented students. (H.?)

ED 173 081 SE 027 836
Sandman, Richard S.

Factors Related to Mathematics Anxiety in the Secondary School.

Pub Date—Apr 79

Note—15p.; Paper presented at the annual meeting of the American Educational Research Association (San Francisco, California, April 8-12, 1979); Not available in hard copy due to marginal legibility of original document

Pub Type—Speeches/Meeting Papers (150)

EDRS Price - MF01 Plus Postage. PC Not Available from EDRS.

Descriptors—*Achievement, *Anxiety, *Attitudes, Classroom Environment, *Mathematics Education, Motivation, Secondary Education, *Secondary School Mathematics, *Sex Differences

Identifiers—*American Educational Research Association

This study indicates that eighth graders have higher mathematics anxiety than eleventh graders, and boys have higher mathematics anxiety than girls. Eighth-grade classes with high mathematics anxiety tend to have high motivation in mathematics, but tend to see mathematics as not very useful in society. Both grade levels show a positive relationship between class mathematics anxiety and both friction and favoritism in the classroom, and a negative relationship between class mathematics anxiety and both class mathematics achievement and the perceived difficulty of the class. (MP)

ED 173 175 SE 028 444
Elmore, Patricia B. Vasu, Ellen S.

A Spectrum Analysis of Attitudes Toward Mathematics: Multifaceted Research Findings.

Pub Date—Apr 79

Note—16p.; Paper presented at the annual meeting of the American Educational Research Association (San Francisco, California, April 8-12, 1979); Contains occasional light and broken type

Pub Type—Reports - Research (143)—Speeches/Meeting Papers (150)

EDRS Price - MF01/PC01 Plus Postage.

Descriptors—Achievement, *Anxiety, *Attitudes, *Career Opportunities, Higher Education, Mathematics Curriculum, *Mathematics Education, Mathematics Instruction, *Research, Secondary Education, Statistics, Symposia

Identifiers—*American Educational Research Association

This symposium includes five presentations of studies of mathematics attitudes at three educational levels: junior high, post-secondary, and graduate school. The studies have implications in the fields of mathematics education, educational research, academic advisement, and career counseling. The studies identify the extent of the problem of mathematics anxiety of avoidance. Abstracts of the papers are presented. Paper topics include: (1) a study of the attitudes of junior high school students toward mathematics; (2)

student's attitudes toward mathematics and their relationship to learning in required mathematics courses in selected postsecondary institutions: (3) mathematics attitudes: an intervention study; (4) math anxiety: its impact on graduate level statistics achievement; and (5) math avoidance and pursuit of fantasy careers. (MP)

MATH ASSESSMENT

ED 161 949 TM 007 988

Phelps, James And Others

Interpretive Manual. The First Report of the 1977-78 Michigan Educational Assessment Program.

Michigan State Dept. of Education, Lansing.
Pub Date—[78]

Note—49p.; Pages 1a through 4a, "Do You Use MEAP Test Results Appropriately?" have been removed due to marginal legibility; they are not included in the pagination.

EDRS Price MF-\$0.83 HC-\$2.06 Plus Postage.

Descriptors—*Achievement Tests, Criterion Referenced Tests, *Educational Assessment, *Educational Objectives, Elementary Secondary Education, Grade 4, Grade 7, Grade 10, Information Utilization, Mathematics, Minimum Competency Testing, Reading, *State Programs, *Testing Programs, *Test Interpretation

Identifiers—Michigan, *Michigan Educational Assessment Program

The Michigan Educational Assessment Program (MEAP) was designed to provide information on the extent to which Michigan students have attained minimal performance objectives. This manual was written to help local Michigan school district staff read, interpret, and use MEAP data. The 1977-78 MEAP provided objective-referenced achievement measures in reading and mathematics for every fourth and seventh grade at the district, building, classroom, and student levels. A voluntary, statewide pilot project was also conducted in grade ten. The reading and mathematics objectives which were measured in grades four, seven, and ten are appended, including item numbers for each objective. Explanations are given of the individual students' report, the classroom report, the school or district summary, the test item analysis, and feeder school and research code reports. Results are not furnished. School district personnel are advised to use the data to: (1) determine which Michigan minimal objectives were taught in which grades; (2) determine which schools had lowest attainment rates and develop strategies to meet these needs; (3) administer post tests of those high priority objectives not attained in September; (4) select one or two schools willing to become demonstration sites; (5) analyze other test data available to the district and relate them to MEAP results. (Author/JAC)

ED 162 861 SE 025 350

Lachat, Mary Ann And Others

An Evaluation of the Oregon System in Mathematics Education, Final Report.

Capla Associates, Inc., Rochelle Park, N.J.
Spons Agency—National Science Foundation, Washington, D.C.
Pub Date—15 Oct 78

Note—185p.; Contains occasional light and broken type

EDRS Price MF-\$0.83 HC-\$10.03 Plus Postage.

Descriptors—*Educational Assessment, *Effective Teaching, Elementary Secondary

Education, Evaluation, Higher Education, *Mathematics Education, Preservice Education, *Program Validation, *Research, State Programs, *Teacher Education, Teaching Skills

Identifiers—*Research Reports

The Oregon System in Mathematics Education (OSME) was a five-year "systems experiment" to improve mathematics education on a statewide basis. The major purposes of this present study were to determine the effectiveness and impact of OSME and a "systems" approach and to address questions of future replicability. The evaluation focused on three broad concerns: (1) to what extent did NSF funding of OSME result in an effective systems model for achieving program improvement on a statewide basis?; (2) what was the impact of OSME on teachers and students?; and (3) what project elements had the greatest potential for transportability? The conclusions include: (1) OSME was a successful program improvement effort; and (2) the factors that made it work include its openness, inclusiveness, flexibility, and trust in project participants. (MP)

ED 164 625 TM 008 481

Achievement in Reading & Mathematics, 6th Grade.

Texas Education Agency, Austin

Pub Date—78

Note—61p.; For related documents, see TM 008 100, 101, and 416; Parts may be marginally legible due to small print

EDRS Price MF-\$0.83 HC-\$3.50 Plus Postage.

Descriptors—Academic Achievement, *Achievement Rating, Behavioral Objectives, Educational Assessment, *Elementary School Mathematics, Grade 6, Intermediate Grades, Norm Referenced Tests, *Performance Factors, *Reading Achievement, *State Surveys, *Student Characteristics, Test Results, Vocabulary

Identifiers—California Achievement Tests, Texas, *Texas Assessment Project

Results of a survey using norm referenced tests of reading and mathematics for a large sample of sixth grade students throughout Texas are reported in detail. Statewide results are reported in terms of percentile ranks of average partial and total scores and in the percentage of students in each quarter of the norms. For each of 20 districts in the state, ethnic group percentages (blacks, Mexican American, and other) and percentile ranks are given. Data are also given for sex, type of school district, family income, special students, and for certain combinations of the above groups. Appendices list essential reading and mathematics objectives; labels and definitions for categories used in classifying data; and scaled scores, percentile ranks, and grade equivalents for reading and mathematics scores for all groups. (CTM)

ED 166 020 SE 025 481

Rubinstein, Sherry Ann Ghiselin, Diane J.
Connecticut Assessment of Educational Progress: Mathematics, 1976-77 Summary Report.

National Evaluation Systems, Inc., Amherst, Mass.

Spons Agency—Connecticut State Dept. of Education, Hartford. Bureau of Research, Planning, and Evaluation.

Pub Date—Sep 77

Note—68p.; For related document, see SE 025 480; Some tables may not reproduce well due to small type

EDRS Price MF-\$0.83 HC-\$3.50 Plus Postage.

Descriptors—*Achievement, Age Differences, *Comparative Analysis, *Educational Assessment, Elementary Secondary Education, Group Norms, *Mathematics Education, Rural Urban Differences, Sex Differences, *Test Results

Identifiers—*Connecticut

In this document, the major outcomes of a study are reported, focusing primarily on the mathematics achievement results. The sections of Part I discuss performance on goal areas and objectives; comparisons of achievement among groups of students within each age level, 9-, 13-, and 17-year-olds; comparisons of the achievement of Connecticut students with that of students nationally; the results of each item by age, sex, religion, and size of community within the state. Part II contains discussions and recommendations in the following areas: math concepts, computation, measurement, problem solving and applications, charts and graphs, and geometry. (MP)

ED 174 648 TM 009 497

Report: 1978 Wisconsin Pupil Assessment Program. Bulletin No. 8169.

Wisconsin State Dept. of Public Instruction, Madison.

Pub Date—78

Note—31p.

Pub Type—Numerical/quantitative Data (110)

—Reports - Research (143)

EDRS Price - MF01/PC02 Plus Postage.

Descriptors—*Academic Achievement, Age Differences, Basic Skills, Calculation, *Educational Assessment, Educational Trends, Elementary Secondary Education, *Mathematics, National Norms, Practical Mathematics, Program Attitudes, *State Programs, *State Standards, Student Attitudes, Testing Programs, *Test Results

Identifiers—Comprehensive Tests of Basic Skills, Wisconsin

The 1978 Wisconsin assessment program, involving students in grades 4, 8, and 12, focused upon: (1) state-developed tests referenced to state objectives for computation and everyday money and measurement skills; (2) the Comprehensive Tests of Basic Skills: mathematics, reading, and language; (3) comparison of results of the 1976, 1977, and 1978 assessment; and (4) relationship of attitudes toward mathematics and previous training to scores on the state-developed tests (grades 8 and 12 only). Fourth graders averaged above the 80th percentile in all areas of the state-developed tests; 8th grade students averaged between 51 and 90% correct; and seniors averaged between 60 and 95% correct. Both seniors and eighth graders had difficulty with fractions. For the third consecutive year, CTBS scores remained above the national norm. Although there was little variation on the state tests for all three grades, the 1978 CTBS scores of grades 4 and 8 declined and were similar to those of 1976. Attitudes toward mathematics were positively related to scores on the state test and to extent of post training. Both eighth and twelfth graders generally felt that their courses were applicable to everyday situations. (CP)

ENVIRONMENTAL EDUCATION

ED 160 285 RC 010 782

Matthews, Bruce And Others

A Guide for Conducting Outdoor Field Experiences.

Cortland-Madison Board of Cooperative Educational Services, Cortland, N.Y.

Pub Date—Feb 78

Note—30p.

Available from — Cortland-Madison B.O.C.E.S. Outdoor-Environmental Ed. Program. McEvoy Educational Center, Cortland, New York 13045 (\$1.00)

EDRS Price MF-\$0.83 HC-\$2.06 Plus Postage.

Descriptors—*Activities, Discovery Learning, Educational Philosophy, Environmental Education, Experiential Learning, *Field Instruction, Field Trips, Games, Interdisciplinary Approach, *Outdoor Education, Planning, *Resource Materials, Sensory Experience, Teacher Improvement, *Teaching Guides, *Teaching Techniques
Identifiers—*Strand Approach to Environmental Education

Since research indicates teachers generally lack confidence in their ability to conduct lessons in the outdoors and feel inadequate regarding knowledge of the natural world, this guide has been developed to build teacher confidence in utilizing the outdoors. Designed to be used in conjunction with a practicum workshop, this guide presents techniques which can be demonstrated and practiced in a workshop situation. The following are addressed: philosophical background of outdoor education, educational assumptions (learning by doing, use of all senses, individual and unique ways of learning, learning by association, the importance of needing to learn, self discovery learning, group dynamics emphasis); the strand approach to environmental education (interdisciplinary learning incorporating variety similarities, patterns, interaction interdependence, continuity change, and adaptation/evaluation); sensory approach (use of all senses); planning field trips (pre-trip preparation, post-trip evaluation, check lists, etc.); activities (strand approach illustrated via activities for each of the five strands listed above, sensory approach activities, discovery approach activities, acclimatizing activities, and miscellaneous activities). Among the many activities listed are the following: empathizing activities, and miscellaneous activities. Among the many activities listed are the following: empathizing with natural phenomena-role playing a tree: prickly-tickly (find something that prickles and something that tickles); the food chain game; a bug's eye view (how the world looks to a bug). (JC)

ED 160 448 SE 025 088
Youth Conservation Corps Source Book of Environmental Awareness; People and Natural Resources.

Department of the Interior, Washington, D.C.; Forest Service (DOA), Washington, D.C.
Pub Date—77

Note—132p.; Contains occasional light and broken type

EDRS Price MF-\$0.83 HC-\$7.35 Plus Postage.

Descriptors—*Conservation Education, *Environmental Education, Field Trips, *Leaders Guides, *Outdoor Education, *Science Education, Work Study Programs

Identifiers—*Youth Conservation Corps

This guide is written for Youth Conservation Corps (YCC) unit managers and staff. It provides philosophies, concepts, methods, and techniques for integrating environmental awareness in YCC camp programs. The first chapter of this sourcebook defines environmental education and gives six goals of environmental education that were a result of a workshop held in Belgrade, Yugoslavia in 1975. The next chapter discusses planning an environmental awareness program. It goes into planning projects, field trips, group liv-

ing, and recreation. Emphasis is given to integrating environmental awareness into work projects. Chapter three presents activities to strengthen team work in the YCC program. It gives examples of solving a problem through group-interaction, role-playing games, the process and problem solving approach to learning, and teaching process skills. The remaining chapters present ecological principles and environmental concepts, an environmental awareness scorecard for evaluating student progress, a discussion of urban youth and the YCC, and the roles of Federal and State agencies. (BB)

ED 161 754 SE 025 244

Gallagher, James Joseph, Ed.

A Guide for Teaching Regional Environmental Planning. Final Report of Project - Inservice Personnel Development: Regional Environmental Planning Workshops for Tri-County Secondary School Teachers.

Michigan State Univ. East Lansing, Science and Mathematics Teaching Center.

Spons Agency—Office of Education (DHEW), Washington, D.C.

Pub Date—Sept 78

Grant—OE-G-007701356

Note—58p.; Contains occasional light and broken type

EDRS Price MF-\$0.83 HC-\$3.50 Plus Postage.

Descriptors—*Environmental Education, Environmental Influences, Inservice Teacher Education, *Instructional Materials, Learning Activities, Natural Resources, *Regional Planning, Resource Materials, *Secondary Education, *Teaching Guides

This guide is designed for teachers, administrators, inservice leaders, and teacher educators. Its purpose is to provide an organizational framework, material, and resources for the development of instructional plans and strategies for incorporating regional environmental planning in the secondary school curriculum. The guide is divided into three major parts. The first relates the role of regional environmental planning in solving some of today's environmental problems. The second part defines and describes regional environmental planning. It covers transportation, water supply, pollution control, waste disposal, and material recycling. The third part presents steps in introducing regional environmental planning into the school or community education programs. Information sources, implementation guidelines, and sample activities are included. (Author/MA)

ED 162 885 SE 025 387
Environmental Education: Food - The Coming Crisis (Grades K-12).

New Jersey Education Association, Trenton; New Jersey State Council for Environmental Education, Upper Montclair.

Spons Agency—Office of Education (DHEW), Washington, D.C.

Pub Date—[71]

Grant—G007501293;

Note—91p.

EDRS Price MF-\$0.83 HC-\$4.67 Plus Postage.

Descriptors—*Activity Units, Ecology, Economics, *Food, Interdisciplinary Approach, Land Use, Objectives, Resource Allocations, Units of Study, *World Problems

This publication presents classroom activities for teaching about the world food shortage. These activities are organized by objectives, are multidisciplinary and cover the K-12 grade levels. The objectives listed include: (1) Describe some food chains; (2) Appraise the effect of soil conditions, geog-

raphic and climatic factors on the food industry; (3) Describe the role of transportation in the distribution of food; (4) Explain the relationship between food and population; (5) Relate food production and processing to energy use; (6) Suggest some solutions to alleviate world hunger; (7) Analyze the relationship between food and economics; (8) Investigate the political aspects of food distribution; (9) Analyze the relationship between agriculture and land use; and (10) Identify factors causing world-wide concern about food. The activities are organized under each objective by problem area, grade level, and subject or course of study. This publication is a part of the "Environment and Quality of Life" series of Computer Based Resource Units that have been developed under the Elementary and Secondary Education Act, Title III. (MR)

ED 185 975 RC 011 160

Whitney, Helen, Comp.

101 Environmental Education Activities, Booklet 4-Science Activities.

Upper Mississippi River ECO-Center, Thompson, Ill.

Spons Agency—Bureau of Elementary and Secondary Education (DHEW/OE), Washington, D.C.

Pub Date—75

Note—89p.; Best copy available.

Available from—Upper Mississippi River ECO-Center, Thomson, Illinois 61285 (\$1.50)

EDRS Price MF-\$0.83 HC-\$4.67 Plus Postage.

Descriptors—Climatic Factors, Conservation (Environment), Curriculum Enrichment, *Curriculum Guides, Ecology, Educational Objectives, *Elementary Secondary Education, Energy, *Environmental Education, Evaluation Criteria, *Experiential Learning, Field Trips, *Instructional Materials, *Outdoor Education, Plant Identification, *Science Activities, Science Course Improvement Project, Science Experiments, *Science Instruction, Sensory Experience, Soil Science

Identifiers—Elementary Secondary Education Act Title III, *Upper Mississippi River ECO Center

Fourth in the series "101 Environmental Education Activities" by the Upper Mississippi River ECO-Center, the booklet contains 39 environment-based science activities directed to students in primary, intermediate, and junior high classes. Organization of the activities usually includes grade level, objectives, procedures, and materials, evaluation criteria, and sometimes includes hints and follow-up activities as well. In general, emphasis is placed on learning about soils; weather; various life forms; ecological and environmental relationships; conservation; natural phenomena; and on enhancing the students' powers of observation, sensory awareness, and awareness of environmental problems. Activities include science and energy surveys, weather observations and predictions, soil study and analysis, tree study, plant and animal observations, and specimen collection. Field trips to forest, timber, marsh, and river areas as well as new housing developments and waste disposal plants help students examine many aspects of their environment from the point of view of various sciences. (SB)

ED 169 564 CS 204 803
Environmental Education Guide; Language Arts 9-12.

Project I-C-E, Green Bay, Wis.

Spons Agency—Office of Education (DHEW), Washington, D.C.; Wisconsin State Dept. of Public Instruction, Madison.

Pub Date—78

Contract—300-77-0105

Note—117p.; For related document, see CS 204 802

Pub Type—Guides - Classroom - Teacher (052)

EDRS Price - MF01/PC05 Plus Postage.

Descriptors — Behavioral Objectives, Ecology, *English Curriculum, *English Instruction, *Environmental Education, *Interdisciplinary Approach, *Language Arts, Listening Skills, Pollution, Reading Skills, Secondary Education, Speech Skills, Validated Programs, Writing Skills

Identifiers—National Diffusion Network Programs, *Project ICE

Written for use with students in grades nine through twelve, this handbook links natural ecological issues with language arts instruction. It contains a series of lesson plans, each offering a number of suggested learning activities for use both in and out of class. The lessons are built around 12 major environmental concepts that form a framework for each subject area. In addition, each lesson offers subject area integration, multidisciplinary activities, cognitive and affective behavioral objectives, and suggested reference and resource materials for both the teacher and students. (FL)

ED 171 807

UD 019 197

Salter, Christopher L. And Others

Scoring Los Angeles Landscapes: Environmental Education in an Urban Setting

California Univ., Los Angeles. Urban Environmental Education Project.

Spons Agency—National Endowment for the Humanities (NEAH), Washington, D.C.

Pub Date—78

Note—112p.; Not available in hard copy due to marginal reproducibility of original document

Pub Type—Guides - Classroom - Teacher (052)

EDRS Price - MF01 Plus Postage. PC Not Available from EDRS.

Descriptors—Activity Units, *Elementary Education, *Environmental Education, *Institutes (Training Programs), Teacher Education, *Urban Areas, *Urban Education

Identifiers—*California (Los Angeles)

This notebook serves as a guide for learning activities in environmental education. Twelve themes are treated in four groups: (1) sense of place includes history and landscape; (2) the natural environment covers air, water, energy, and landforms; (3) the built environment includes architecture, transportation, and housing; and (4) the social environment covers population, politics, and planning. Each unit contains a theme sheet and a topic outline. Many units also contain worksheets and activity guidelines. (MC)

ED 174 436

SE 028 253

Introductory Curriculum Materials, Project SCATE.

Iowa State Dept. of Public Instruction, Des Moines, Div. of Curriculum.

Spons Agency — Office of Education (DHEW), Washington, D.C.

Pub Date—[76]

Note—55p.; Not available in hard copy due to marginal legibility of original document

Pub Type — Guides - Classroom - Teacher (052)

EDRS Price - MF01 Plus Postage. PC Not Available from EDRS.

Descriptors — *Conservation (Environment), Critical Reading, Critical Thinking, Decision Making, Economic Factors, Energy, Environment, *Environmental Education, Inductive Methods, Land Use, *Problem Solving, Science Education, *Secondary Education, Units of Study, *Values

The objective of Project SCATE (Students Concerned About Tomorrow's Environment) is for students to investigate environmental problems and the political processes involved in their solution. The four identified areas of concern are: (1) land use policy development; (2) air and water quality; (3) energy allocation and consumption; and (4) economic considerations related to the quality of life. This document contains instructional units, including objectives and activities, centering around the four concerns. Unit titles are: (1) Identifying a problem; (2) Clearly stating a problem; (3) Determining testable and non-testable statements; (4) Generalizing; (5) Model Assembly; (6) Land Use; (7) Discovering a biological community; (8) Children's forest controversy; (9) Great swamp; and (10) Urban studies. (TM)

ENERGY EDUCATION

ED 159 022

SE 024 802

Carey, Helen H., Ed.

Award Winning Energy Education Activities for Elementary and High School Teachers.

National Science Teachers Association, Washington, D.C.

Spons Agency — Energy Research and Development Administration, Oak Ridge, Tenn.

Report No. —ERHQ-0011

Pub Date—77

Note—52p.; Type size is small on some pages Available from—ERDA Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee 37830 (no price quoted)

EDRS Price MF-\$0.83 HC-\$3.50 Plus Postage.

Descriptors—*Elementary Secondary Education, *Energy, *Energy Conservation, Environmental Education, Heating, *Instructional Materials, *Science Activities, Science Education, Solar Radiation

This publication contains descriptions of the winning entries to the National Science Teachers Association (NSTA) Teacher Participation Contest conducted in 1976. This was a nationwide contest for the design of activities around energy themes at any grade level, K-12. The ten winning entries described here are: (1) Energy Units for Primary Grades; (2) Aluminum Recycling Experiment; (3) Energy in Art and Energy is All Around Us; (4) Black Gold; (5) Energy, Economy, Education; (6) Local Investigation in Container Use; (7) Kill A Watt; (8) Idea, Designing an Energy-Efficient House; (9) Solar Heating and Cooling; and (10) Living with Wind Power. Many of these winners are designed for the senior high school. Each one has included a brief summary of what the activity teaches, what the students do, and how the activity might fit into the existing curriculum. (MR)

ED 160 418

SE 025 042

Gerlovich, Jack A.

Energy Concepts in the Iowa School Curriculum

Iowa State Dept. of Public Instruction, Des Moines, Div. of Curriculum

Pub Date—Oct 78

Note—32p.

EDRS Price MF-\$0.83 HC-\$2.06 Plus Postage.

Descriptors—Conservation (Environment), *Curriculum Development, *Elementary

Secondary Education, *Energy, *Energy Conservation, *Program Descriptions, Science Activities, Science Education

Identifiers—Iowa

This document reports on the Iowa Department of Public Instruction plan to integrate energy education into elementary and secondary programs. This plan includes the development of energy conservation activity packets. The packet contain a variety of interdisciplinary activities, accompanying worksheets, visuals, and annotated children and teacher bibliographies for grades K-8. Also included in the plan is the Mankato State University Energy Program which is designed to acquaint teachers with some classroom projects that can be done by students in grades 7-12, and give teachers an extended classroom project in which students evaluate the energy consumption of their school. Finally, this report presents the results of a questionnaire designed to assess the present energy programs and perceived energy needs of Iowa secondary school teachers. The dominant concerns of the teachers surveyed were energy conservation and the political and social aspects of energy problems. (BB)

ED 161 727

SE 025 192

Energy Conservation Activities for the Classroom K-12.

Kentucky Dept. of Energy, Frankfort; Kentucky State Dept. of Education, Frankfort.

Pub Date—[78]

Note—244p.

EDRS Price MF-\$0.83 HC-\$1.21 Plus Postage.

Descriptors—*Conservation Education, Curriculum Guides, Elementary Secondary Education, *Energy Conservation, *Environmental Education, *Learning Activities, *Science Activities, Science Education, Teaching Guides

After a brief introduction entitled "Where Does the Energy We Use Come From," this unit presents 86 activities. Each activity gives the title, concept, objectives, subject area, level, time involved, materials needed, procedures, and related career activities. Topics cover everything from housing insulation to alternate sources of energy to energy use by appliances and automobiles. The activities include game playing, science experiments, surveys, field trips, and others. The unit concludes with a bibliography. (BB)

ED 162 886

SE 025 390

An Educator's Introduction to Energy Concepts: Overview Packets.

Maine Audubon Society, Falmouth.

Spons Agency — Office of Education (DHEW), Washington, D.C.

Pub Date—Nov 77

Grant—G007602036

Note—68p.; Pages 9, 10 of "Consumption Lifestyles" section removed due to copyright restrictions; Not available in hard copy due to marginal legibility of original document.

EDRS Price MF-\$0.83 Plus Postage. HC not Available from EDRS.

Descriptors—Conservation (Environment), *Energy Conservation, *Environmental Education, Information Sources, Instructional Materials, Natural Resources, Physics, Social Studies, *Sociocultural Patterns, *Teaching Guides

Identifiers—*Energy Education

This publication provides a broad overview of energy and related issues for teachers and others who want to improve their understanding of these issues. Included in this publication are discussions of: (1) elementary

physics related to energy; (2) energy sources, including topics such as renewable and non-renewable resources and fossil fuels; (3) energy uses in the U.S.; (4) thermodynamics; (5) space heating; (6) energy conservation; and (7) socioeconomic aspects of the energy crisis. The last section entitled Consumption/Life Style is designed for social science teachers and discusses the effects of population increases on natural resources and social values. Diagrams and tables are provided to illustrate, among other things: (1) energy consumption rates of various electric appliances; (2) energy uses by economic sector; (3) U.S. energy flow from source to work and waste; and (4) the flow of energy to and from earth. (MR)

ED 164 283 SE 025 380
Energy: Pennsylvania's Energy Curriculum for the Middle Grades.

Governor's Energy Council, Harrisburg, Pa.;
 Pennsylvania State Dept. of Education,
 Harrisburg.

Pub Date—77

Note—217p.: Drawings may not reproduce well.

EDRS Price MF-\$0.83 HC-\$11.37 Plus Postage.

Descriptors—*Activity Units, Curriculum Design, *Curriculum Guides, *Energy Conservation, *Environmental Education, Experiential Learning, Instructional Materials, *Interdisciplinary Approach, *Junior

High Schools, Objectives, Student Attitudes, Surveys

Identifiers—Energy Education, *Pennsylvania Department of Education

This publication is an energy curriculum for grades 7 through 9. In each of the six modules a number of activities are provided. The module titles are: (1) Energy: What is it About?; (2) Energy: Where Does it Go?; (3) Energy: Its Present Sources; (4) Energy: Policy and Prospects; (5) Energy: Is There Another Way?; and (6) Energy: How Can I Help? Objectives, explanations of what to do, and teacher's notes are given for each activity. Where needed, diagrams, tables and other teaching aids are provided for direct copying. The types of activities range from simple lab experiments to group discussions. Other features of this publication include a bibliography, a list of possible audio-visual aids, and an attitude survey to help measure the effect of these energy education materials. This curriculum is designed to be an interdisciplinary and fairly complete energy education program which ultimately brings students to energy conserving lifestyles. However, teachers may easily adapt modules and activities to fit their own designs. (MR)

ED 167 391 SE 026 772

Solar Energy Education Bibliography.

Center for Renewable Resources,
 Washington, D.C.

Spons Agency — Office of Education

(DHEW), Washington, D.C. Energy and Education Action Center.

Pub Date—Feb 79

Contract—300-78-0151

Note—44p.: Not available in hard copy due to marginal legibility of original document

Pub Type—Reference Materials - Bibliographies (131)

EDRS Price MF-\$0.83 Plus Postage. HC Not Available from EDRS.

Descriptors—Audiovisual Aids, Books, Elementary Secondary Education, *Energy, *Instructional Materials, Natural Resources, Postsecondary Education, *Solar Radiation
 Identifiers—*Energy Education

This annotated bibliography lists publications and audiovisual materials devoted to renewable energy sources: sun, wind, water and biomass. A few general texts are included that present concepts fundamental to all energy sources. Materials were selected to be adaptable to classroom, workshops, and training sessions. Also, many do-it-yourself consumer/home owner materials are included. Technical books are listed as they may be useful to students and professionals. Publications are grouped by grade level. Films, videocassettes, slide shows, and filmstrips are listed according to energy source subject. Prices, sources, and grade level are given with the description of each audiovisual item (Author/MR)

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